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GROUNDWATER RESOURCES OF THE BERWICK-BLOOMSBURG-DANVILLE AREA, EAST-CENTRAL PENNSYLVANIA

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GROUNDWATER RESOURCES OF THE BERWICK-BLOOMSBURG-DANVILLE AREA, EAST-CENTRAL PENNSYLVANIA

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ABSTRACT

The area of investigation is in the valley of the North Branch Susquehanna River and surrounding uplands, and occupies parts of Columbia, Luzerne, Montour, and Northumberland Counties in east-central Pennsylvania. Two major towns in the area, Bloomsburg and Danville, are supplied by surface water, but Berwick and other communities depend on groundwater, as do many industrial and commercial facilities and almost all rural homeowners.

The bedrock underlying the area is of Silurian, Devonian, and Mississippian age and includes gradational sequences of noncarbonate and carbonate lithologies. The bedrock units are folded in broad anticlinoria and synclinoria typical of the Appalachian Mountain section of the Valley and Ridge province. In the bedrock aquifers, groundwater flows through secondary-permeability features such as fractures, bedding-plane separations, and solution openings. The bedrock aquifers have a strong directional permeability along bedding strike. The development of secondary permeability is largely controlled by the amount of calcareous material in an aquifer, and the carbonate rock of the Keyser and Tonoloway Formations is, accordingly, the most productive bedrock aquifer.

Unconsolidated deposits of sand, gravel, silt, and clay, primarily of glacial origin, overlie much of the bedrock. The most extensive stratified deposit is the sand and gravel outwash of late Wisconsinan age that occupies the Susquehanna River and Fishing Creek valleys. Because of its high primary permeability, the glacial-outwash aquifer has a great capacity to receive, store, and transmit water.

Well yields for the aquifers were estimated from data on specific capacity, depth to water-bearing zones, and water levels. The median estimated well yields for the aquifers range from 5 gallons per minute for the Trimmers Rock Formation to 190 gallons per minute for glacial outwash. The highest yields from wells in the study area typically can be developed in the glacial-outwash aquifer and in bedrock aquifers containing significant amounts of carbonate rock. About one of every four wells completed in the outwash sand and gravel is capable of yielding 410 gallons per minute or more. About one of every four wells completed in the Keyser and Tonoloway Formations, the Onondaga and Old Port Formations, and the Wills Creek Formation is capable of yielding 620, 310, and 130 gallons per minute or more, respectively.

The results of 139 chemical analyses show that groundwater chiefly is the calcium bicarbonate type. Most groundwater tapped by wells is usable for domestic supply and human consumption, although hardness, iron, manganese, and hydrogen sulfide gas that exceed maximum recommended concentrations may cause problems locally. Water from aquifers containing carbonate rock generally is hard to very hard. Iron concentrations that exceed 300 μg/L were observed in 46 percent of the wells sampled and manganese concentrations that exceed 50 μg/L were observed in 40 percent of the wells. Hydrogen sulfide gas was detected in 9 percent of the wells sampled. Problems with concentrations that exceed recommended limits for these constituents are more common in groundwater from the Devonian rocks that contain black shale, although excess manganese also is a common problem in the glacial-outwash aquifer.

INTRODUCTION

This report concerns the hydrogeologic system of the Berwick-Bloomsburg-Danville area in east-central Pennsylvania. The aquifers that underlie the area, the groundwater flow system, and the water-yielding capabilities of the aquifers are described, the factors that affect well yields are discussed, and the quality of groundwater in the area is characterized. The study was conducted from September 1979 to September 1982 as part of the continuing appraisal of the groundwater resources of Pennsylvania by the U.S. Geological Survey and the Pennsylvania Geological Survey.

Groundwater is a main source of supply for domestic, municipal, industrial, and commercial use in the Berwick-Bloomsburg-Danville area. As the economic and population growth continues, the importance of developing and managing the groundwater resources becomes crucial. The information in this report will assist municipal and water-authority officials, planning boards, consulting geologists and engineers, well drillers, commercial and industrial concerns, regulatory agencies, and rural homeowners in the development and management of groundwater.

LOCATION AND PHYSIOGRAPHIC SETTING

The study area is in the valley of the Susquehanna River and surrounding uplands in east-central Pennsylvania (Figure 1). The 370-square-mile area includes the Berwick, Bloomsburg, Mifflinville, Millville, and Washingtonville 7½-minute quadrangles, and the northern halves of the Catawissa, Danville, and Riverside 7½-minute quadrangles. The area occupies central Columbia County, almost all of Montour County, and parts of west-central Luzerne and northern Northumberland Counties.

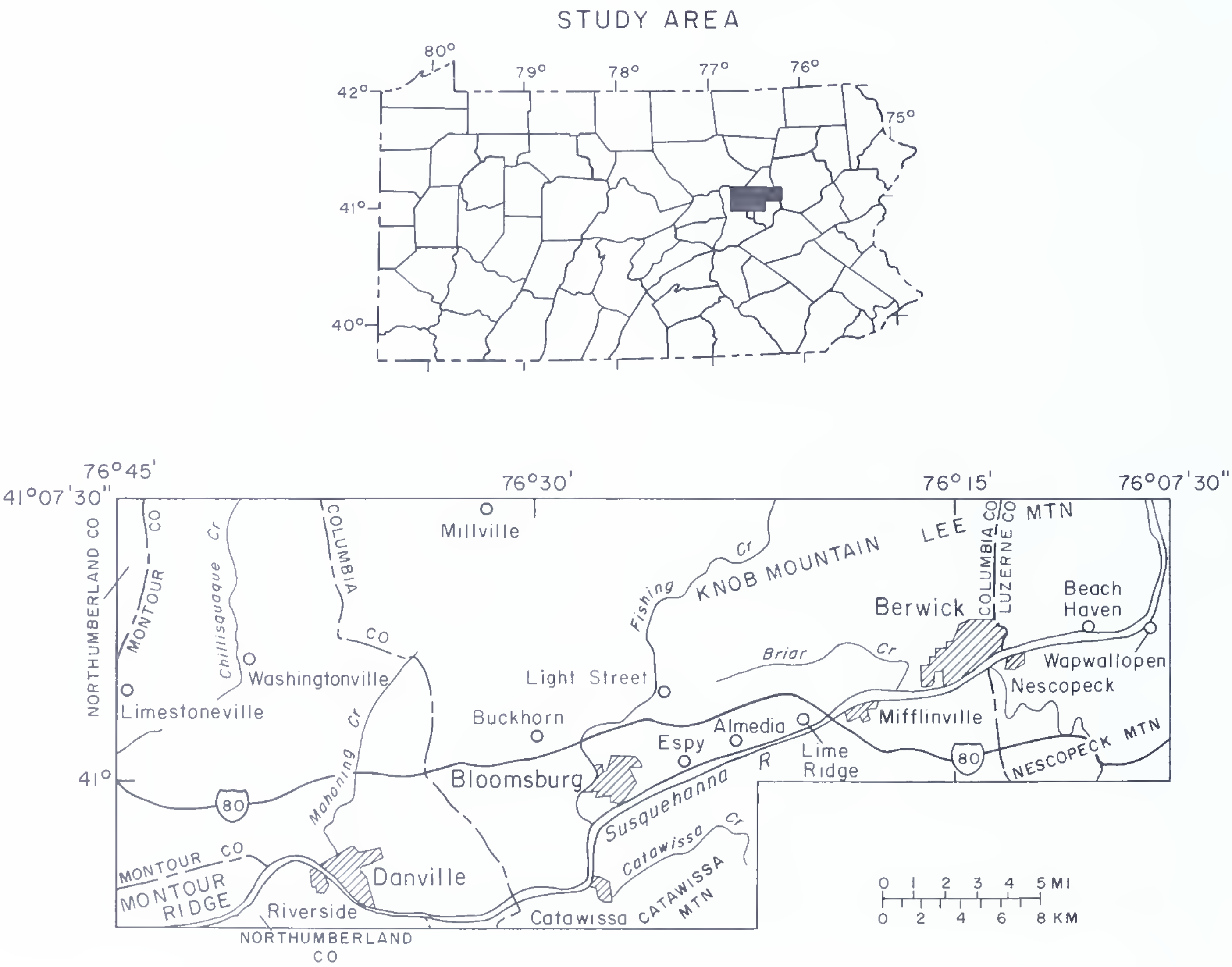


Figure 1. Location, physiographic features, and population centers of the study area.

The area lies within the Appalachian Mountain section of the Valley and Ridge physiographic province. The topography ranges from relatively flat terraces and floodplains along the Susquehanna River and its major tributaries to steeply wooded slopes of mountain ridges. Altitudes range from 440 feet above sea level at the Susquehanna River at Danville to 1,760 feet above sea level on Knob Mountain, east of Orangeville. Major tributaries to the Susquehanna River include parts of Fishing Creek, Mahoning Creek, Catawissa Creek, Briar Creek, and Nescopeck Creek. The northwestern part of the study area is drained by Chillisquaque Creek, which flows to the West Branch Susquehanna River.

The major centers of population are found along the Susquehanna River and include Berwick, Nescopeck, Mifflinville, Bloomsburg, Catawissa, Danville, and Riverside. Interstate Route 80 transects the study area in an east-west direction.

GROUNDWATER USE

Table 1 shows an inventory of the major groundwater users in the Berwick-Bloomsburg-Danville area in 1980. The boroughs of Berwick, Bloomsburg, Catawissa, Danville, Mifflinville, Millville, and Orangeville have public water supplies and distribution systems. Bloomsburg and Danville are supplied by surface water. The Bloomsburg Water Authority withdraws about 2.5 Mgal/d (million gallons per day) from Fishing Creek, and the Danville Water Authority withdraws about 1.7 Mgal/d from the Susquehanna River. Merck Chemical Company withdraws about 0.5 Mgal/d from the Susquehanna River at Riverside.

In 1980, about 4.7 Mgal/d of water was obtained from wells and springs by the major groundwater users. Additional groundwater is pumped from wells and springs to meet rural domestic, agri-

Table 1. *Major Groundwater Users in the Berwick-Bloomsburg-Danville Area*

County	Name	Estimated groundwater withdrawal in 1980 (gal/d)	Aquifer	Source and remarks
Columbia	Bloomsburg Mills, Inc.	600,000	Old Port and Keyser Fms.	3 drilled wells pumped for 4 months for air conditioning
	Champion Valley Farms	500,000	Onondaga and Old Port Fms.	3 drilled wells pumped for cooling and cleaning
	Catawissa Water Authority	155,000	Catskill Fm.	6 drilled wells and 3 springs
	Consolidated Cigar Co.	—	Wills Creek Fm.	1 drilled well, pumped at 200 gal/min for air conditioning
	Keystone Water Co. (Berwick)	2,900,000	Old Port and Keyser Fms.	3 drilled wells
	Mifflin Township Water Authority	55,000	Glacial outwash	2 drilled wells
	Millville Water Authority	85,800	Alluvium and till; Mahantango Fm.	1 drilled well and 2 dug wells
	Orangeville Water Authority	13,800	Catskill Fm.	1 drilled well and 6 springs
	Scenic Knolls Water Co.	10,000	Wills Creek and Bloomsburg Fms.	3 drilled wells
	Schultz Electroplating, Inc.	6,000	Bloomsburg Fm.	1 drilled well
	Wonderview Water Co.	28,000	Trimmers Rock and Mahantango Fms.	3 drilled wells
Luzerne	Citizens Water Co.	8,000	Trimmers Rock Fm.	1 drilled well and 3 springs
Montour	Geisinger Medical Center	148,000	Mifflintown and Keefer Fms.	3 drilled wells (70 percent) and 1 spring
	Mahoning Township Water Authority	186,000	Keyser Fm. and upper member of Rose Hill Fm.	2 drilled wells
	TRW, Inc.	30,000	Keyser and Tonoloway Fms.	2 drilled wells
Northumberland	Hillside Estates	6,000	Mahantango Fm.	2 drilled wells

cultural, and small commercial needs in areas outside those served by public supplies. Groundwater accounts for about half of the total water used in the study area.

METHODS OF INVESTIGATION

Nearly 800 wells and test holes were inventoried for measurements of well and casing depth, depth to water and water-bearing zones, and well yield and drawdown (Table 23). The inventory included almost all public-supply wells and most industrial and commercial wells. Selected springs also were inventoried (Table 24). Nine observation wells were drilled by the U.S. Geological Survey. Five of these 6-inch-diameter wells were completed in bedrock, and four wells having 6-inch-diameter slotted casing were completed in glacial outwash. Eleven auger holes were drilled in glacial outwash; four of the auger holes were cased with 2-inch-diameter slotted pipe. Information was collected on about 130 pumping tests; U.S. Geological Survey personnel conducted or assisted in most of the tests. Twenty-eight of the pumping tests were multiple-well tests involving a pumping well and one or more observation wells. Borehole geophysical logs were run on 43 wells. Well-bore-flow tests were made in 25 wells (Table 2) by the brine-tracing method outlined by Patten and Bennett (1962). Continuous water-level records were obtained for varying periods of time at 16 wells. Synoptic water-level measurements were made on 79 wells along the Susquehanna River between Bloomsburg and Berwick in December 1980 and April 1981. Field determinations of specific conductance and hardness were obtained from 299 wells (Table 23), and water samples for laboratory analyses were collected from 139 wells (Tables 21 and 22).

The bedrock geology was mapped by Inners (1978, 1981), Way (in press), Williams (1980), Berg and others (1980), and Nickelsen (1978, written communication). The geologic base map (Plate 1) was compiled by the U.S. Geological Survey and the Pennsylvania Geological Survey.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the cooperation and assistance of the landowners, companies, municipalities, and state agencies who provided information on wells, granted permission to drill test holes, and allowed access to wells.

Many well drillers provided information and assistance. Special thanks is extended to Gene Wieand of Wieand Brothers Drilling for his interest and time.

The Susquehanna River Basin Commission provided additional funds for detailed work along the Susquehanna River between Berwick and Bloomsburg. The authors thank Gregory Senko of the Commission for his able assistance in field work and data storage and retrieval. The authors also thank Timothy Gregorowicz and David Hassrick of Bloomsburg State College, Department of Geology, for field work on the well inventory.

GEOLOGIC SETTING

BEDROCK

The bedrock or consolidated rock that underlies the Berwick-Bloomsburg-Danville area is of Silurian, Devonian, and Mississippian age and includes sedimentary noncarbonate and carbonate lithologies. The bedrock units are briefly described in Table 3, and the areal distribution of the formations is shown on Plate 1.

Large-scale folding and subsequent erosion largely account for the outcrop patterns of the bedrock units shown on Plate 1. The bedrock has been folded into a series of anticlinoria and synclinoria (Figure 2). The major structural trend is N70–75°E. Bedding dips typically are 35 to 45 degrees along the limbs of the folds. The Light Street fault, a major thrust fault, transects the study area. The fault generally follows the structural trend in the stratigraphic sequence of the Wills Creek Formation through the Mahantango Formation.

The bedrock has been systematically fractured by two major sets of joints. One set of planar fractures is oriented parallel to the structural grain (strike joints) and the other set is at right angles to the structural grain (dip joints). The joints range from continuous fractures that transect a large stratigraphic sequence to discontinuous breaks that are restricted to single beds. Most strike and dip joints are oriented normal to bedding planes. Strike joints fan across the major folds. The joints are moderately to steeply inclined and dip north and south in south- and north-dipping beds, respectively. Dip joints are approximately vertical regardless of structural setting (Inners, 1981). Oblique joints, irregular fractures, and cleavage-plane partings are also present. All fractures in the bedrock tend to close with depth because of increasing overburden pressures.

Table 2. *Index to Geophysical Logs and Well-Bore-Flow Tests for Selected Wells*[1]

Well no.	Co-45	Co-60	Co-61	Co-62	Co-70	Co-85	Co-154	Co-190	Co-205	Co-206	Co-212
Depth of logs	270	226	350	120	473	444	40	400	244	60	120
TYPE OF LOG											
Temperature	x	x	x		x	x	x	x	x	x	x
Fluid conductance	x	x	x	x	x	x		x	x		x
Caliper	x	x	x	x	x	x		x	x	x	x
Electric	x		x	x	x	x	x	x	x		
Gamma	x	x	x	x	x	x	x	x	x	x	
Well-bore flow											
Nonpumping						x			x		x
Pumping	x		x								x

Well no.	Co-245	Co-304	Co-305	Co-306	Co-307	Co-308	Co-310	Co-448	Co-452	Co-459	Co-460
Depth of logs	440	200	68	124	300	52	220	145	500	136	120
Temperature	x	x	x	x	x	x	x	x	x		x
Fluid conductance	x	x		x	x			x	x		x
Caliper	x	x		x	x		x	x	x	x	x
Electric	x	x		x	x		x	x	x	x	x
Gamma	x	x	x	x	x	x			x	x	
Well-bore flow											
Nonpumping	x	x		x	x			x	x		x
Pumping											x

Well no.	Co-461	Co-505	Co-562	Lu-438	Lu-452	Lu-453	Lu-454	Lu-471	Mt-29	Mt-30	Mt-31
Depth of logs	195	568	152	230	102	300	200	471	300	400	505
Temperature	x	x		x	x	x	x	x	x	x	x
Fluid conductance	x	x		x		x	x	x	x	x	
Caliper	x	x	x	x	x	x	x	x	x	x	x
Electric	x	x	x	x		x	x	x	x	x	x
Gamma	x	x		x	x	x	x	x	x		x
Well-bore flow											
Nonpumping		x		x		x	x		x		
Pumping				x				x			

Well no.	Mt-108	Mt-154	Mt-175	Mt-181	Mt-186	Mt-255	Nu-157	Nu-158	Nu-187	Nu-188
Depth of logs	265	156	285	250	276	223	300	300	96	72
Temperature	x	x	x	x	x	x	x	x	x	
Fluid conductance	x	x	x	x	x	x	x	x	x	x
Caliper	x	x	x	x	x	x	x	x	x	x
Electric		x		x	x		x	x	x	x
Gamma		x		x	x		x	x	x	x
Well-bore flow										
Nonpumping					x	x		x		
Pumping	x		x					x	x	x

[1]Logs and data on well-bore-flow tests are on file with the U.S. Geological Survey, Harrisburg, Pennsylvania.

Table 3. *Description of Bedrock Geologic Units*[1]

System	Geologic unit	Thickness (feet)	Lithologic description
Mississippian	Mauch Chunk Formation	[2]2,500	Interbedded grayish-red shale, siltstone, and sandstone; calcareous in part.
	Pocono Formation	600–650	White to light-gray quartzitic sandstone and pebble conglomerate; some interbeds of dark-gray shale.
Devonian	Catskill Formation		
	Duncannon Member	1,100	Repetitive fining-upward cycles of greenish-gray and grayish-red sandstone, grayish-red siltstone, and grayish-red shale that are mostly 30 to 65 feet thick.
	Sherman Creek Member	2,500	Interbedded grayish-red shale, siltstone, and sandstone.
	Irish Valley Member	1,800–2,000	Interbedded shale, siltstone, and sandstone; alternating gray to greenish gray and grayish red in the upper part; mostly gray to greenish gray in the lower part.
	Trimmers Rock Formation	2,500	Predominantly interbedded gray to dark-gray siltstone and shale; considerable amount of sandstone in the upper part and shale in the lower.
	Harrell Formation	100	Dark-gray shale, interbedded with siltstone in the upper part.
	Mahantango Formation		
	Tully Member	50–60	Interbedded argillaceous limestone and calcareous shale; dark gray, fossiliferous.
	Lower member	1,100–1,200	Greenish to dark-gray shale, locally calcareous; some calcareous and fossiliferous siltstone beds in the upper part.
	Marcellus Formation	300	Dark-gray fissile shale, pyritic and carbonaceous.
	Onondaga Formation	50–175	Interbedded gray argillaceous limestone and calcareous shale in the upper part; gray to dark-gray noncalcareous to very calcareous shale in the lower part.
	Old Port Formation	150	Variable lithologic sequence, consisting of dark-gray, slightly calcareous chert, locally sandy and fossiliferous, in the upper part; dark-gray calcareous shale in the middle part; dark-gray, fine- to coarse-grained, cherty, fossiliferous limestone in the lower part.
Devonian and Silurian	Keyser Formation	125	Gray to bluish-gray limestone, fine- to coarse-grained, thin- to thick-bedded; laminated, argillaceous and dolomitic in the upper part; coarse grained and highly fossiliferous in the middle part; nodular, argillaceous, and fossiliferous in the lower part; calcareous shale interbeds increase in frequency in the upper part.
Silurian	Tonoloway Formation	200	Laminated, gray to dark-gray, fine-grained limestone; considerable dolomitic limestone and dolostone in the lower part; calcareous shale interbeds increase in frequency and thickness toward base.
	Wills Creek Formation	600–700	Interbedded calcareous shale, argillaceous dolostone and limestone, and calcareous siltstone; gray, yellowish gray, and greenish gray in the upper part; variegated greenish gray, yellowish gray, and grayish red purple in the lower part.
	Bloomsburg Formation	500	Grayish-red shale containing interbeds of grayish-red siltstone, calcareous in part; 30-foot-thick interval of grayish-red sandstone in the upper part.
	Mifflintown Formation	200	Dark-gray limestone and calcareous shale in the upper part; dark-gray calcareous shale containing interbeds of coarse-grained limestone in the lower part.
	Keefer Formation	40	Light-gray quartzitic sandstone and siltstone containing interbeds of greenish-gray shale.
	Rose Hill Formation		
	Upper member	120	Interbedded shale, limestone, and sandstone; mostly gray to greenish gray.
	Middle member	60	Reddish-purple hematitic sandstone containing interbeds of greenish-gray to reddish-purple shale in the upper part.
	Lower member	720	Greenish-gray shale containing interbeds of gray calcareous sandstone and reddish-brown hematitic sandstone.
	Tuscarora Formation	350	Interbedded light-gray quartzitic sandstone and grayish-green shale.

[1]Adapted from Inners (1981).
[2]Only the lower 1,000 feet is exposed in the study area.

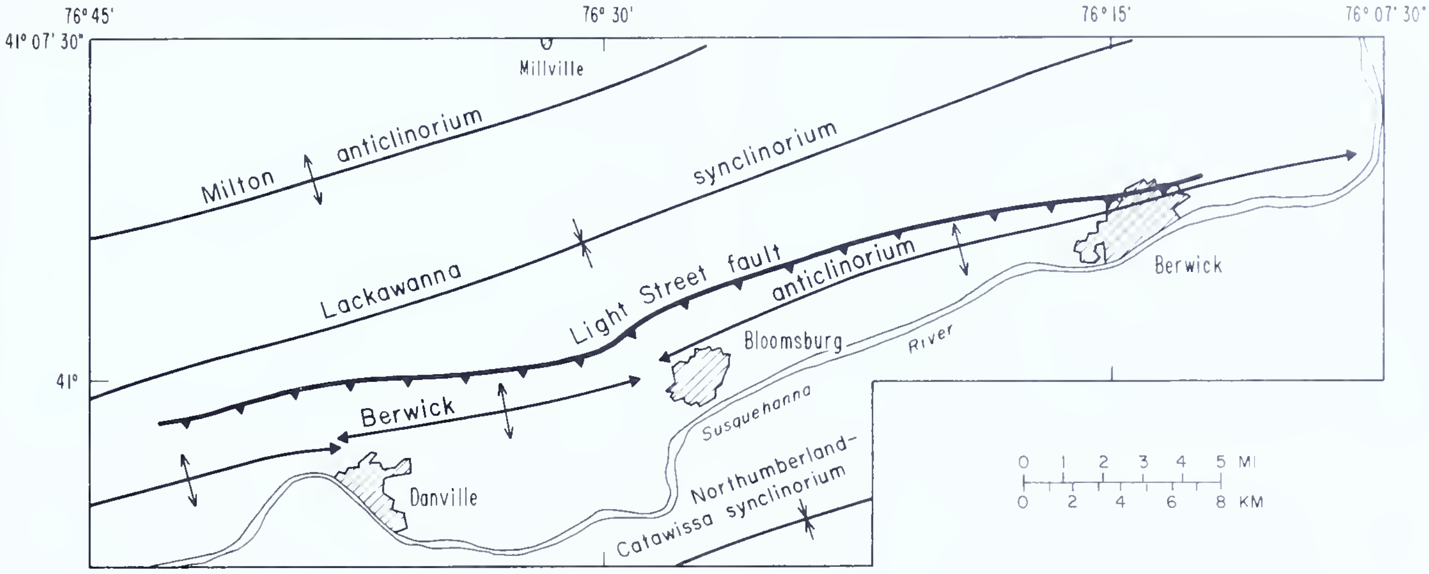


Figure 2. Structural setting of the study area (from Inners, 1978; Inners and Way, 1979; Williams, 1980; Inners, 1981; and Way, in press).

UNCONSOLIDATED DEPOSITS

The unconsolidated deposits of sand, gravel, silt, and clay that overlie the bedrock are largely the result of glaciation. There is evidence that several glacial advances occurred during Pleistocene time. Early advances in pre-Wisconsinan time covered the study area. Early Wisconsinan glaciation covered approximately 20 percent of the area (Inners, 1978, 1981). The terminal moraine in the Susquehanna River valley near Berwick marks the extent of the latest glacial advance in late Wisconsinan time.

The glacial deposits can be broadly subdivided into two groups—nonstratified and stratified deposits. The nonstratified deposits are till, which is a generally unsorted mixture of clay, silt, sand, gravel, and boulders, largely of local origin, that was directly deposited by a glacier. Pre-Wisconsinan and Wisconsinan tills are found in the study area. Till masks the bedrock in much of the area and has a thickness of generally less than 20 feet, although deposits 50 to 100 feet thick are present locally along the southern base of Knob and Lee Mountains.

Stratified deposits include poorly to well-sorted sand, gravel, silt, and clay that were transported and deposited by glacial meltwater as ice-contact or outwash deposits. Pre-Wisconsinan stratified deposits, locally more than 50 feet thick, are found in the Light Street-Buckhorn area north of Bloomsburg. The most extensive stratified deposits are late Wisconsinan sand and gravel outwash deposits found in the Susquehanna River and Fishing Creek valleys. In general, the thickness and coarseness of the outwash decrease downstream from the late Wisconsinan glacial border. Along the Susquehanna River upstream from Wapwallopen, silt and clay are locally interbedded with the outwash sand and gravel. Many of the recent alluvial and colluvial deposits in the area are reworked glacial sediments.

HYDROGEOLOGIC DESCRIPTION OF THE AQUIFERS

BEDROCK AQUIFERS

Groundwater in the bedrock formations is present in secondary openings along fractures and bedding-plane separations (Figure 3). Primary permeability of bedrock in the area is negligible. Solution of calcareous material, especially along fractures and bedding planes, greatly increases the secondary permeability of carbonate rock (Figure 4). The ability of the bedrock aquifers to store and transmit water, as well as to yield water to wells, depends on the size, interconnection, and spacing of secondary openings. Fractures and bedding-plane partings cause hairline separations that allow movement of groundwater. The separations in competent lithologies, such as sandstone, dolostone, and limestone, tend to remain more open than the separations in the less competent shales.

The size of secondary openings in carbonate lithologies may be greatly enlarged by removal of calcareous material. Openings several feet wide have been penetrated in wells drilled into the Tonoloway,

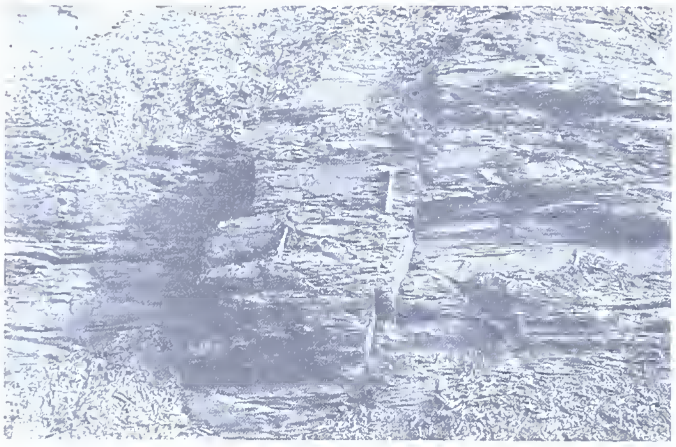


Figure 3. Planar fractures or joints developed in the Mahantango Formation. Groundwater occurs in secondary openings along fractures and bedding-plane separations in the bedrock aquifers.

Figure 4. Solution openings in the Keyser Formation. Development of solution openings, primarily along fractures and bedding-plane separations, greatly increases the secondary permeability of carbonate rock.

Keyser, and Old Port Formations. Solution of calcareous material also appears to be important in the development of permeability in the dominantly noncarbonate rocks. As indicated by hydrogeologic logs of wells Co-306 and Nu-158 (Table 4), many water-bearing zones in the noncarbonate-rock aquifers appear to be associated with vein calcite and calcareous cement.

In a stratigraphic sequence, the density of fractures differs from bed to bed, and some fractures may be restricted to single beds. In addition, the susceptibility of the rock to solution differs from bed to bed depending on the amount of calcareous material present. These factors, as well as the presence of bedding-plane separations, create

Table 4. *Hydrogeologic Logs of Selected Wells*

(Yields in parentheses are the discharges produced by the air-rotary drillstem at the given depth)

Depth (feet below land surface)	Hydrogeologic description
Co-305	
	Glacial outwash
0–39	Sand, grayish-brown, medium to coarse, containing quartz and rock fragments, and gravel, fine to coarse; pebble lithologies in gravel include sandstone, siltstone, shale, quartz-pebble conglomerate, quartzite, chert, and metamorphic rock.
39–55	Sand, grayish-brown, fine to coarse, containing quartz and rock fragments including particulate anthracite coal, and some fine gravel; pebble lithologies in gravel include those listed above plus anthracite coal.
55–65	Sand, grayish-brown, medium, containing quartz and rock fragments, and gravel, fine to coarse; gravel content increases toward base; casing slotted from 55 to 65 feet.
	Marcellus Formation
64–68	Shale, dark-gray, silty, noncalcareous.
Co-306	
	Glacial outwash
0–5	Sand, light-brown, silty, fine, and gravel, medium.
0–39	Sand, light-brown, fine, and gravel, medium to coarse. Water-bearing zone at 35 feet (3 gal/min, cased off).
	Marcellus Formation
39–55	Shale, gray, calcareous.
55–60	Shale, gray, calcareous; some vein calcite; water-bearing zone at 60 feet (3 gal/min).
60–70	Shale, gray, slightly calcareous; fossil fragment.
70–75	Shale, gray, calcareous; some vein calcite; water-bearing zone at 74 feet (20 gal/min).
75–80	Shale, gray, slightly calcareous.
80–85	Shale, gray, calcareous; calcite veins up to 0.1 inch wide.
85–125	Shale, gray, slightly calcareous; some vein calcite.

Table 4. *(Continued)*

Depth (feet below land surface)	Hydrogeologic description
Co-307	
	Glacial outwash
0-45	Sand, light-brown, medium, and gravel, fine to coarse; sandstone boulders at 27 and 32 feet; water-bearing zone at 37 feet (1 gal/min, cased off).
	Tonoloway Formation
45-55	Limestone, gray, fine-grained.
55-65	Limestone, light-gray, fine-grained; some vein calcite; water-bearing zone at 62 feet (3 gal/min).
65-70	Limestone, dark-gray, fine-grained; cuttings smelled of hydrogen sulfide during drilling.
70-80	Limestone, dark-gray, fine- and medium-grained; some vein calcite.
80-95	Limestone, gray and dark-gray, fine- and medium-grained; abundant vein calcite.
95-100	Limestone, gray, fine-grained, and vein calcite; weathered yellowish brown; water-bearing zone at 96 feet (20 gal/min).
100-105	Limestone, gray, fine-grained; some vein calcite; cuttings smelled of hydrogen sulfide during drilling.
105-112	Limestone, dark-gray, medium-grained; vein calcite, some coarse-grained.
112-113	Vein calcite, coarse-grained.
113-116	Limestone, dark-gray, fine- to medium-grained; some vein calcite.
116-120	Limestone, gray, fine- to medium-grained; water-bearing zone at 116 feet (40 gal/min).
120-125	Limestone, gray, fine-grained; abundant vein calcite.
125-130	Limestone, gray, fine- and medium-grained; some vein calcite.
130-135	Limestone, gray, fine-grained.
135-140	Limestone, light-gray, fine-grained, and vein calcite, coarse-grained.
140-150	Dolostone, light-gray, fine-grained.
150-155	Dolostone, light-gray, fine-grained, shaly; some vein calcite.
155-160	Dolostone, light-gray, fine-grained, shaly, and vein calcite, coarse-grained.
160-170	Dolostone, light-gray, fine-grained; some fine-grained pyrite.
170-180	Limestone, light-gray, fine-grained; yield increased between 120 and 180 feet (90 gal/min).
180-185	Limestone and dolostone, light-gray, fine-grained.
185-210	Dolostone, light-gray, fine-grained; some vein calcite.
210-215	Limestone and dolostone, light-gray, fine-grained, shaly; some vein calcite.
215-220	Limestone, light-gray, fine-grained.
	Wills Creek Formation
220-225	Dolostone, light-gray, fine-grained, and shale, greenish-gray.
225-235	Limestone, light-gray, fine-grained; some fine-grained pyrite.
235-240	Limestone and dolostone, light-gray, fine-grained, shaly; some fine-grained pyrite.
240-245	Limestone, gray, fine- and medium-grained.
245-255	Limestone, light-gray, fine- and medium-grained; some coarse-grained vein calcite.
255-265	Dolostone, gray, fine- and medium-grained, and shale, greenish-gray.
265-270	Dolostone and limestone, gray, fine- and medium-grained.
270-275	Limestone, gray, fine-grained.
275-280	Shale, greenish-gray, and dolostone, gray, fine-grained, shaly.
280-285	Dolostone, gray, fine-grained.
285-290	Limestone and dolostone, dark-gray, fine- and medium-grained.
290-293	Dolostone, gray, fine- and medium-grained; coarse-grained vein calcite at 292 feet.
293-295	Dolostone, gray, fine-grained, shaly.
295-300	Shale, greenish-gray, and dolostone, gray, fine-grained; yield increased between 280 and 300 feet (110 gal/min).
Nu-158	
	Mahantango Formation
0-15	Soil, brownish-orange, clayey; some fragments of shale.
15-35	Shale, gray, calcareous; brownish stains; water-bearing zones at 22 and 30 feet.
35-80	Shale, dark-gray, calcareous.
80-85	Shale, dark-gray, slightly calcareous.
85-95	Shale, dark-gray, calcareous; abundant vein calcite; some finely disseminated pyrite; water-bearing zone at 88 feet.
95-140	Shale, dark-gray, calcareous; some vein calcite and finely disseminated pyrite; water-bearing zone at 108 feet.
140-155	Shale, dark-gray, slightly calcareous.
155-160	Shale, dark-gray, calcareous; some vein calcite.
160-235	Shale, dark-gray, slightly calcareous; some brownish stains.
235-300	Shale, dark-gray, slightly calcareous; some finely disseminated pyrite; water-bearing zone at 289 feet.

abrupt changes in permeability at bedding contacts. These permeability changes at bedding contacts, the presence of strike joints, and a common bedding dip of 35 to 45 degrees cause the characteristic development of directional permeability in the bedrock aquifers along bedding strike.

In general, the bedrock aquifers display relatively small, discrete zones of high permeability that are surrounded by large blocks of unfractured, low-permeability rock. Overall, the bedrock aquifers display relatively low storage capabilities due to the large amount of unfractured rock.

GLACIAL-OUTWASH AQUIFER

Groundwater is present in primary openings between grains in unconsolidated deposits. The ability of the unconsolidated deposits to store and transmit water depends on grain size, degree of sorting, saturated thickness, and areal extent of saturation. Locally, only the late Wisconsinan outwash deposits have significant permeability and areal saturation. The sand and gravel deposits of the glacial-outwash aquifer are highly permeable and have significant storage capabilities. In general, the thickest saturated deposits are found along Fishing Creek upstream from Orangeville and along the Susquehanna River upstream from Mifflinville.

The areal extent of the outwash aquifer and its thickness observed in wells and test holes are shown on Plate 1. Generalized sections of the outwash aquifer in selected areas are also presented on Plate 1.

The glacial-outwash aquifer is discontinuous. Sections A–A′ and C–C′ indicate that thick glacial aquifers are present locally along the upper outwash-terrace area northeast of Beach Haven. The outwash aquifers occur up to 100 feet above the Susquehanna River. Along the Susquehanna River north of Wapwallopen, 70 feet of saturated glacial deposits occurs below the level of the river. However, as previously mentioned, significant amounts of silt and clay are found interbedded with the outwash sand and gravel in this area.

At Nescopeck (section D–D′), the Susquehanna River flows on bedrock, and the greatest aquifer thickness is present 3,000 feet away from the river. At Mifflinville (section E–E′), a buried channel is present about 1,000 feet away from the Susquehanna River. A bedrock high, in part, isolates the buried-channel-deposit aquifer from the river. The hydrogeologic log of one well, Co–305, completed in the glacial outwash of the buried channel is presented in Table 4. A hydrogeologic section across the outwash terrace along Fishing Creek north of Orangeville (section F–F′) indicates a relatively uniform aquifer thickness of about 50 feet of saturated deposits under the creek.

GROUNDWATER FLOW SYSTEM

WATER BUDGET

Precipitation in the Berwick-Danville area is about 40 inches per year. The precipitation represents about 700 million gallons per square mile per year and, except for through-flowing streams, is the source of all fresh water in the area. Water leaves the area as water vapor in the atmosphere, as streamflow, and as groundwater flow. A water budget represents a balance of the components of the hydrologic system as follows:

$$P = R + WL$$

where P = annual precipitation, in inches
R = groundwater and surface-water runoff (total streamflow), in inches
WL = water loss (evapotranspiration), in inches

This form of the budget implies that groundwater flow across basin boundaries is negligible, and that changes in groundwater and soil-moisture storage also are negligible for the budget period.

Water budgets were calculated for the East Branch Chillisquaque Creek and Fishing Creek drainage basins above U.S. Geological Survey gaging stations 01553600 and 01539000 (Table 5). The locations of the gaging stations are shown on Plate 1. The period 1962–77 was used to represent average climatic conditions, the period 1963–66 was used for drier than average conditions, and the period 1972–75 was used for wetter than average conditions.

In the East Branch Chillisquaque Creek basin, about 43 percent of the average annual precipitation is discharged as streamflow, and most of the remainder is lost as evapotranspiration. Average annual water losses for the wet and dry periods were 45 and 66 percent, respectively. The basin is located in a lowland underlain by shale and is probably representative of similar settings in the study area.

In the Fishing Creek basin, about 57 percent of the average annual precipitation is discharged as streamflow. Average annual water losses for the wet

Table 5. *Water Budgets for Selected Drainage Basins*

Basin name	U.S. Geological Survey gaging-station number	Drainage area (square miles)	Water years	Precipitation[1] (inches)	Runoff (inches)	Percent runoff	Water loss (inches)	Percent water loss
East Branch Chillisquaque Creek	01553600	9.48	1962–77	40.4	17.2	43	23.2	57
			1963–66	33.3	11.4	34	21.9	66
			1972–75	50.3	27.1	54	22.8	45
Fishing Creek	01539000	247	1962–77	40.4	22.9	57	17.5	43
			1963–66	33.3	17.4	52	15.9	48
			1972–75	50.3	31.9	63	18.4	37

[1]National Oceanic and Atmospheric Administration station at Millville.

and dry periods were 37 and 48 percent, respectively. Fishing Creek drains an upland area underlain by sandstone and shale and glacial deposits, mostly north of the study area. On the average, annual water losses are 6 inches less for Fishing Creek than for East Branch Chillisquaque Creek. The lower evapotranspiration for the Fishing Creek basin is attributed to lower annual temperatures and greater runoff from steeper slopes in the upland basin. Although the proportion of precipitation that was annual water loss varied, the amount of water losses remained relatively constant during dry and wet periods in both basins.

RECHARGE

The main source of groundwater recharge is precipitation. From May to September, when evapotranspiration rates are highest and there is a soil-moisture deficit, only a small proportion of rainfall reaches the water table. During the late fall, winter, and early spring, when evapotranspiration is minimal and the soil-moisture deficit has been satisfied, infiltrating rainfall and snowmelt readily recharge the groundwater system.

Groundwater recharge occurs in all areas upgradient from valley discharge points (streams and springs), but the rate of recharge in any specific area is largely controlled by the slope of the land, the infiltration capacity of surficial cover, and the ability of the underlying aquifer to transmit water from the recharge area. The gentle topography and coarse texture of the glacial-outwash terraces provide important areas for recharge. Road surfaces, parking lots, rooftops, and other impermeable surfaces reduce the area available for groundwater recharge and increase runoff to streams.

Groundwater discharge to streams was determined by separating the base-flow component of total runoff on streamflow hydrographs. The groundwater discharge in Table 6 approximates the amounts of annual recharge (assuming that there is no change in storage from year to year and that groundwater evapotranspiration is negligible) in the selected drainage basins for water years 1964 (below average precipitation), 1970 (average precipitation), and 1973 (above average precipitation). By assuming that recharge equals groundwater discharge, recharge was estimated to average about 8.3 inches per year (270 (gal/min)/mi^2 [gallons per minute per square mile]) in the East Branch Chillisquaque Creek basin and about 15 inches per year (490 (gal/min)/mi^2) in the Fishing Creek basin. On average, it is estimated that about one fourth of

Table 6. *Groundwater Contribution to Runoff for Selected Drainage Basins*

Water year	1964			1970			1973			1964, 1970, 1973 Average		
Basin name	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water
East Branch Chillisquaque Creek	16.2	6.7	41	16.9	8.4	50	23.5	9.9	42	18.9	8.3	44
Fishing Creek	19.9	14.2	72	21.6	14.9	69	31.7	16.9	53	24.4	15.3	63

annual precipitation recharges the groundwater system.

MOVEMENT AND DISCHARGE

Groundwater moves through openings in the aquifer from areas of higher to areas of lower hydraulic head. The water table is a subdued expression of the topography. Therefore, in general, groundwater flow is from areas of higher to areas of lower elevation.

Three types of flow systems in the report area are local, intermediate, and regional. Much of the groundwater flow is local, and the nearest stream serves as the discharge point. Drainage divides of local groundwater flow systems coincide closely with surface-water divides. Groundwater in the intermediate system flows under local stream basins and discharges to downstream points of the streams or to larger streams. Only a very small percentage of groundwater flow bypasses the local and intermediate systems and becomes part of the deep, regional flow system.

As groundwater flows, hydraulic head is lost due to frictional resistance to flow through interstices and fractures. Thus, hydraulic-head gradients are an indication of aquifer permeability. Highly permeable aquifers have less resistance to flow, and, therefore, greater amounts of water are able to move through these rocks under smaller gradients. The relatively low gradients associated with the glacial-outwash terrace, less than 50 feet per mile, indicate high permeabilities. In contrast, head gradients in the upland areas underlain by lower-permeability rock of the Tuscarora and Pocono Formations may be greater than 1,000 feet per mile.

The greatest topographic gradients typically are across bedding strike, which is the direction of minimum permeability. Groundwater follows a steplike flow pattern in response to the variable permeabilities across bedding strike. In valleys where the highly permeable carbonate rocks of the Keyser and Tonoloway Formations form an effective drain, hydraulic-head gradients do not closely follow topographic gradients. Groundwater flow is largely toward the carbonate-rock aquifer and then along bedding strike within that aquifer toward points of discharge.

Wells that penetrate water-bearing zones having different hydraulic heads serve as a short circuit to the natural flow system. The amount of well-bore flow depends on the difference in head between water-bearing zones and the location and permeability of the zones. Well-bore flow may connect local, intermediate, or regional flow systems. Well-bore flow measured in eight wells is illustrated in Figure 5.

In uplands, deeper water-bearing zones have lower hydraulic heads than shallow zones, and the flow is downward. Water levels generally are lower in deeper wells than in shallow wells. Head differences between zones probably are on the order of tens of feet, but may be greater than 100 feet near large topographic breaks. Downward flow was measured in two wells, Co-245 and Nu-158, which are located in upland draws. The wells provide a short circuit that connects the local and intermediate flow systems. Downward flow decreases the amount of available drawdown to a well and may cause local dewatering of the shallow aquifer. Measured downward flows, about 1 to 5 gal/min (gallons per minute), exceed the amount that would normally be pumped from a domestic well, and, where such wells are closely spaced, the downward flow may exceed the local recharge rate.

In valleys, deeper water-bearing zones have higher hydraulic heads than shallow zones, and the flow is upward. Water levels generally are higher in deeper wells than in shallow wells. Composite water levels for wells that tap major deep water-bearing zones in discharge areas may be tens of feet higher than those for surrounding shallow wells. Some deep wells in valleys are flowing wells. In other wells, the upper water-bearing zones act as thieving zones, and no indication of upward flow can be seen at the land surface. Although upward flow increases the available drawdown to a well, it is not always desirable. Water produced from the deeper zones typically is higher in dissolved solids, and upward flow may contaminate shallow aquifers. Calcium sulfate water under high hydraulic head is present at a depth of 290 feet in well Mt-31. This well, located in a valley flat, taps the Old Port and Keyser Formations and yields water having a total-dissolved-solids content of 1,040 mg/L (milligrams per liter), which exceeds the recommended limit for drinking water set by the U.S. Environmental Protection Agency (1976a). Well Co-505, which had 13 gal/min of upward well-bore flow, is contrary to this generalization. The water produced from the major water-bearing zone at 550 feet in the well contained less than one half the total dissolved solids than the water produced from shallower zones.

Downward flow was measured in wells Co-304 and Lu-454, both of which are located in the Sus-

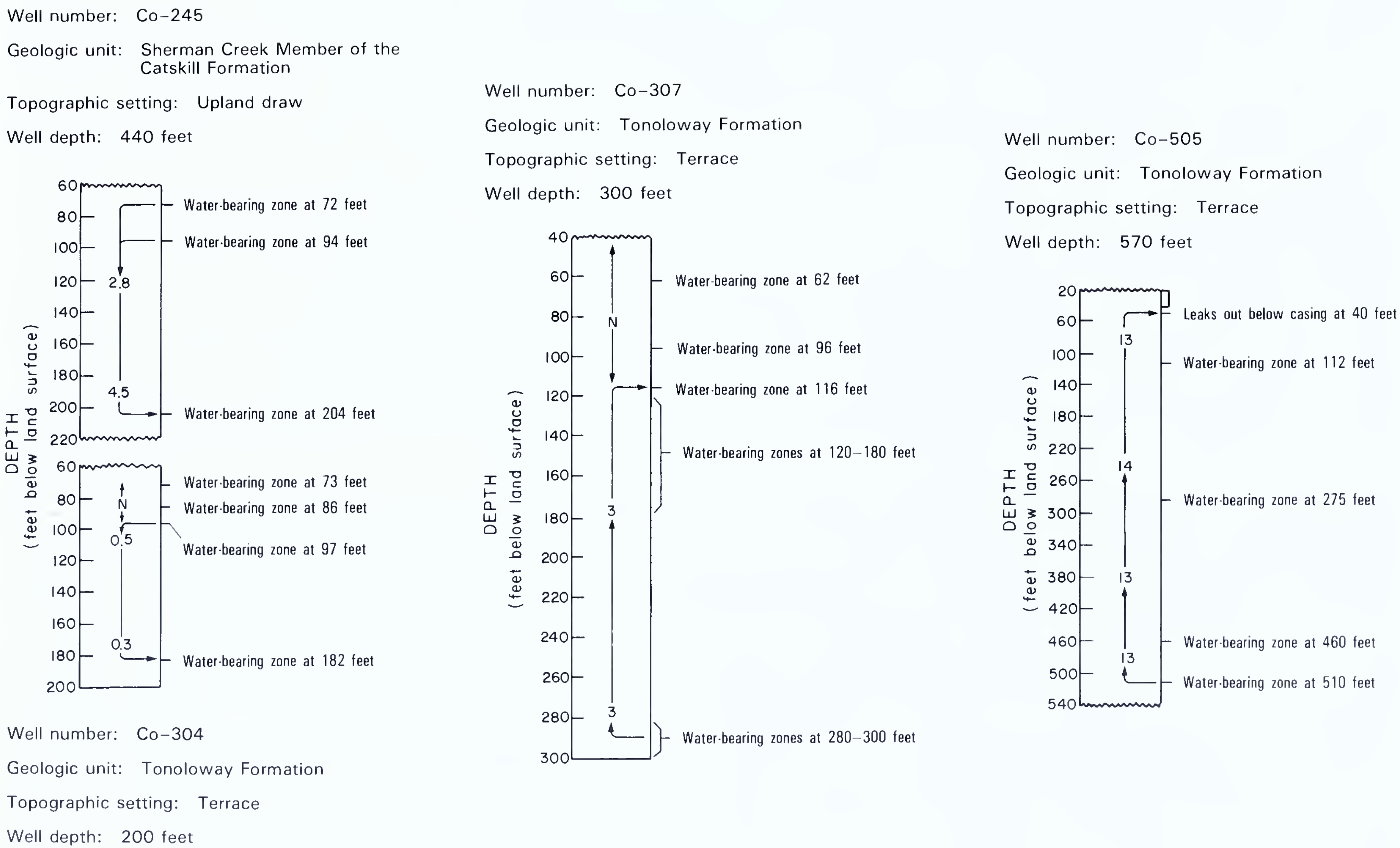


Figure 5. Well-bore flow in selected wells. Arrows and numbers signify direction and rate of flow in gallons per minute; N indicates no measurable flow.

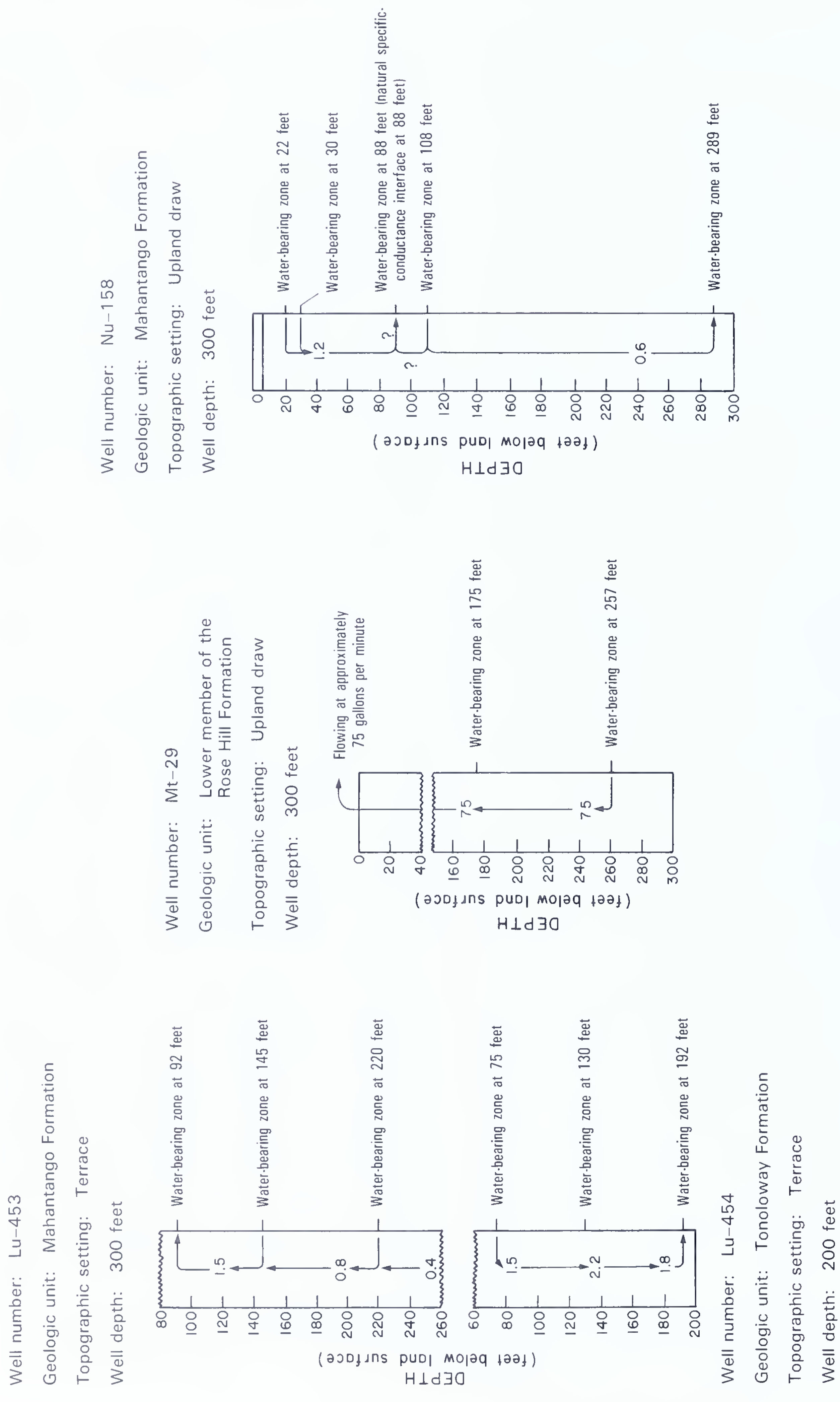


Figure 5. *(Continued).*

quehanna River valley. Possibly, groundwater flows parallel to the river for a distance before discharging, or the lower water-bearing zones in these wells may be part of the regional flow system.

Upward flow is common in wells drilled in the interbedded sandstone, limestone, and shale of the Mifflintown, Keefer, and Rose Hill Formations on the limbs of the Berwick anticlinorium. This hydrogeologic setting is along the flanks of Montour Ridge and its eastern extension between Danville and Bloomsburg. Shales commonly are confining beds for coarser grained and calcareous beds in these formations. Large vertical head differences are found along the limbs of the anticlinorium, where steep topographic gradients parallel the bedding dip, and many flowing wells are encountered. Upward flows measured in wells were generally less than 10 gal/min. An extreme example is well Mt-29, where flow in the well was 75 gal/min upward from a water-bearing zone at a depth of 257 feet (Figure 5); the hydraulic head in the well was 69 feet above land surface.

The natural groundwater flow system has been altered along the flanks of the ridge between Danville and Bloomsburg in areas where deep mining of sedimentary iron ore in the upper part of the Rose Hill Formation occurred in the 1800's (Inners and Williams, 1983). Abandoned deep mines can act as a drain, effectively dewatering overlying water-bearing zones. Wells drilled into the mines provide a short circuit for water perched by overlying confining shales (Figure 6). The most extensive deep mines are found in the Mahoning Creek gap at Danville and on the northern flank of the ridge northeast of Danville. Where the mines are flooded, they may serve as significant sources of water.

A more recent impact on the groundwater flow system from surficial mining activities was caused by sand and gravel dredging operations along Fishing Creek west of Light Street (Figure 7). Removal of sand and gravel in this area effectively increased aquifer permeability and caused the hydraulic gradient toward the creek to flatten. Reportedly, this caused the dewatering of shallow, dug wells (30 to 40 feet deep) in the town of Light Street.

Water-temperature gradients measured in most wells approach the geothermal gradient at depths greater than 300 feet below land surface. This indicates that most groundwater flow occurs within 300 feet of land surface. Fresh water circulates deeper than 600 feet below land surface in much of the study area. Saline water was encountered, however, in two wells drilled into the Marcellus and Mahantango Formations at depths of 300 to 350 feet. The wells, Co-382 and Lu-471, are in valleys at altitudes of 580 and 500 feet above sea level, respectively.

WATER-LEVEL FLUCTUATIONS

Water levels in wells fluctuate in response to changes in recharge and discharge of the groundwater system. Water-level fluctuations primarily are caused by seasonal changes in recharge. Groundwater levels generally start to decline in April and continue to decline throughout the summer. During the summer, high evapotranspiration rates reduce the amount of water reaching the water table, even though rainfall is slightly higher in the summer than during the other seasons. Water levels tend to stabilize in early fall, primarily because of decreased evapotranspiration losses. Rain and snowmelt recharge the aquifers from late fall to early spring, and water levels rise. In well Co-45 at Bloomsburg, for the period 1970 to 1980, April and September showed the highest and lowest mean monthly water levels, respectively. The difference in mean water levels for these months was 2.1 feet.

Hydrographs of wells Co-305 and Co-307, and precipitation for the 1981 water year (October 1980 to September 1981), are shown in Figure 8. The greatest amount of recharge occurred during February. The water level in well Co-307, completed in the Tonoloway Formation, rose 6.4 feet during the month. The water level in well Co-305, completed in glacial outwash, rose 1.8 feet in February and early March. About 6 inches of precipitation fell during February. Although comparable amounts of precipitation occurred in June and July, evapotranspiration losses significantly reduced the amount of water reaching the aquifers. The water level in well Co-305 remained relatively stable during June and July, while the water level in well Co-307 declined 1.3 feet.

The median water-level rise for 79 wells in the Berwick-Bloomsburg area between December 22, 1980, and April 30, 1981, was 2.5 feet (Table 7). The seasonal water-level changes varied according to topography and aquifer lithology (Gerhart and Williams, 1981). On the average, the observed fluctuation on hilltops was three times greater than that in valleys. The wells in valleys are near the Susquehanna River or Fishing Creek, which have nearly constant heads and moderate seasonal water-level fluctuations. In hilltop and slope settings, shale aquifers show the least water-level fluctuation

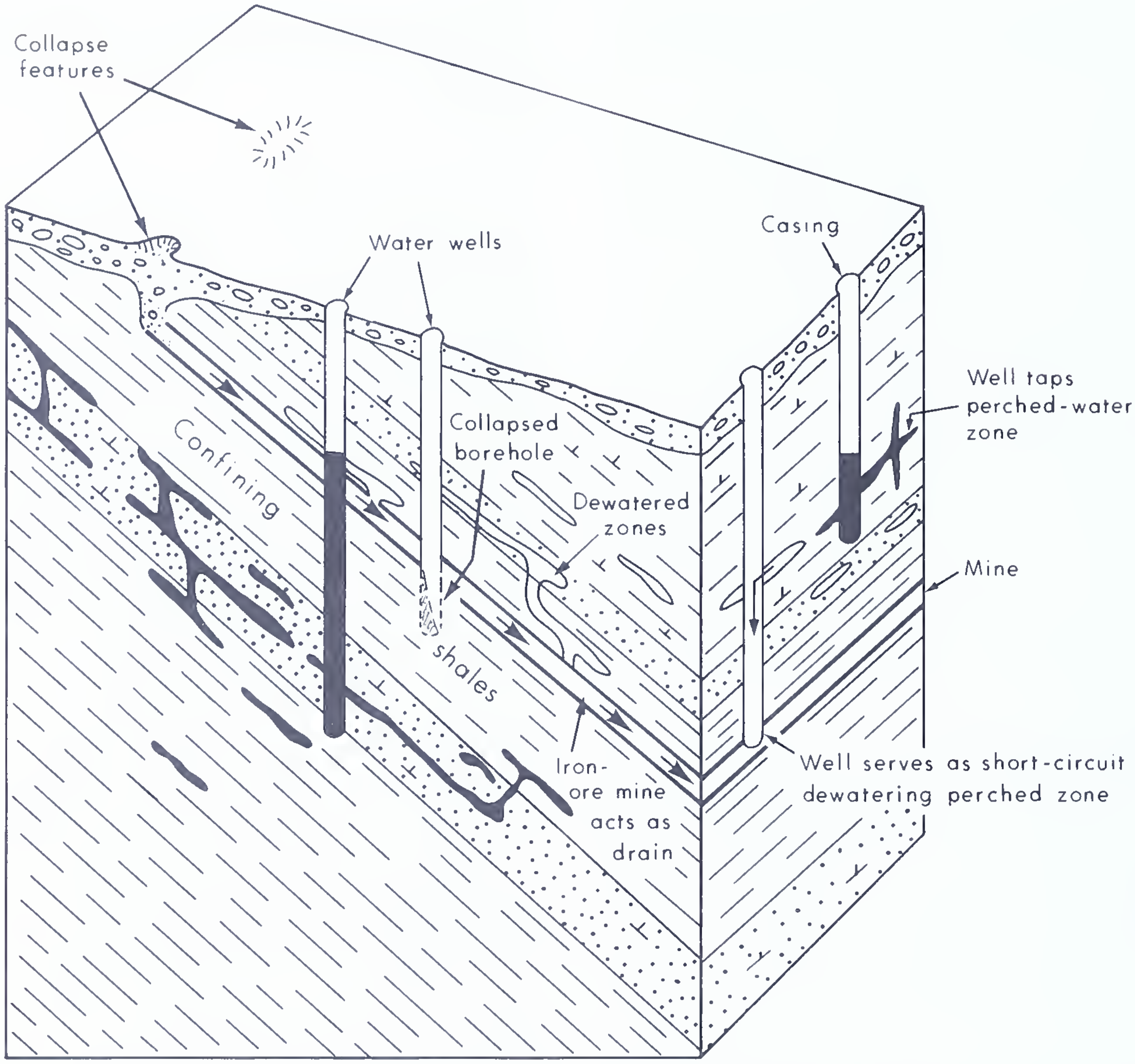


Figure 6. Effects of deep iron-ore mines on the groundwater resources in areas along the flanks of the ridge between Danville and Bloomsburg (from Inners and Williams, 1983).

Figure 7. Sand and gravel dredge pools along Fishing Creek west of Light Street. Dredging operations reportedly caused the dewatering of shallow, dug wells in Light Street.

because the low permeability of the shale decreases the recharge and drainage capability. In valleys, the sand and gravel aquifer shows less water-level fluctuation than bedrock aquifers because of its greater storage capability (greater storage means greater volumes of water drained per foot of water-level decline).

Groundwater levels also fluctuate in response to changes in discharge from the aquifers due to pumping (Figure 9). The water level in well Co-310 at Bloomsburg, completed in the Keyser Formation, fluctuates in response to pumping of an industrial well field located about 2,500 feet to the east (Figure 9). The well field was pumped from June 2 to September 4, 1981 (except for 5 days in late June and early July) for air-conditioning water at a rate in the range of 500 to 1,000 gal/min. This increased discharge from the aquifer accentuated the seasonal

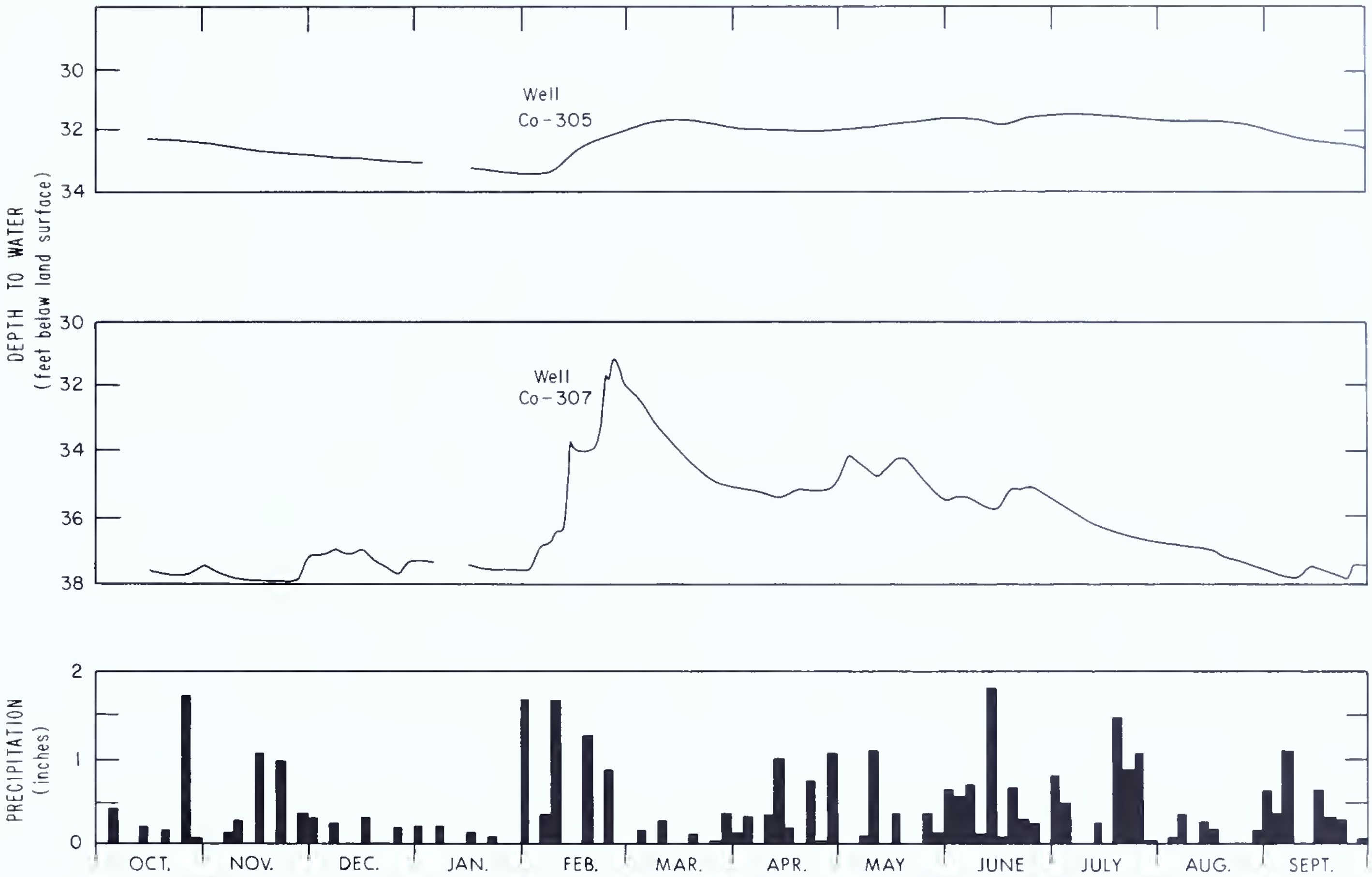


Figure 8. Precipitation at Millville in water year 1981 and corresponding water levels in wells Co-305 (glacial outwash) at Mifflinville and Co-307 (Tonoloway Formation) at Berwick.

Table 7. *Summary of Water-Level Changes in Selected Wells Between December 1980 and April 1981*

Lithology	Median water-level fluctuation (feet)[1]			
	Hilltop	Slope	Valley	All
Sand and gravel	—	1.9 (2)	1.5 (10)	1.5 (12)
Shale	– 0.1 (2)	3.2 (25)	2.3 (12)	2.4 (39)
Sandstone and shale	7.8 (5)	4.8 (3)	—	6.3 (39)
Sandstone, limestone, and shale	10.7 (2)	6.6 (1)	1.9 (1)	7.3 (4)
Carbonate rock and shale	6.1 (1)	1.6 (3)	3.4 (5)	2.8 (9)
Carbonate rock	—	—	2.5 (7)	2.5 (7)
All	6.9 (10)	3.0 (34)	2.3 (35)	2.5 (79)

[1]Positive number denotes a water-level rise from December 1980 to April 1981. Number of wells is in parentheses.

water-level decline in well Co-310. The water level in well Co-310 declined 6.5 feet during this period. During the same time period, well Co-190, located nearby but not affected by pumpage, showed a water-level decline of less than 1 foot. The well field was pumped on an intermittent basis until September 28. The water level in well Co-310 recovered 4.9 feet from September 28 to December 31, 1981, whereas the water level in well Co-190 rose only 0.3 foot during the same period.

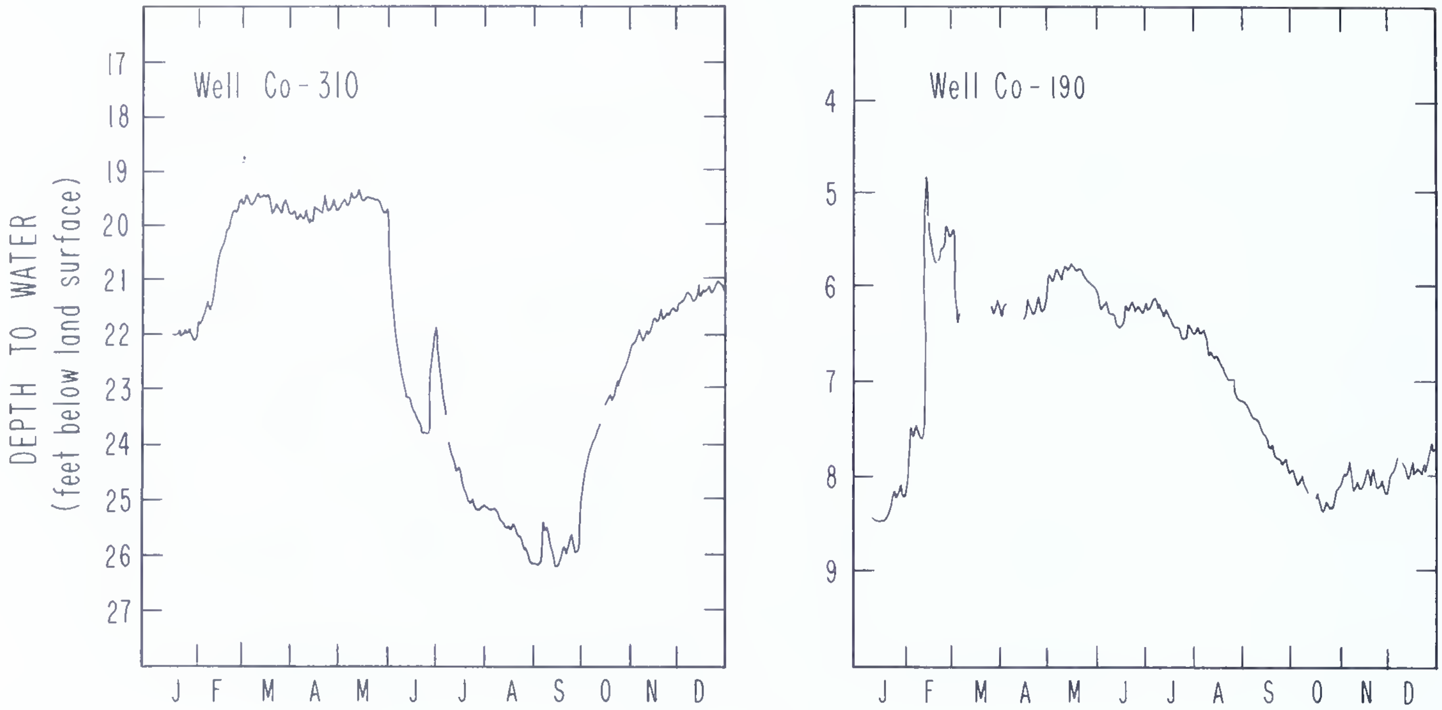


Figure 9. Comparison of water-level fluctuations in wells Co-310 and Co-190 at Bloomsburg for the 1981 calendar year. Water levels in well Co-310 are affected by the pumping of an industrial well field for summer air-conditioning water.

WATER-YIELDING CHARACTERISTICS OF THE AQUIFERS

WELL CONSTRUCTION

In the area of investigation, dug wells, springs, and, most commonly, drilled wells are used for groundwater withdrawal. Air-rotary or cable-tool methods are used to drill wells.

Depths of drilled wells that were inventoried range from 33 to 610 feet. About 70 percent of the inventoried wells were drilled for domestic, small commercial, or other purposes for which yields of 5 to 10 gal/min are generally adequate. The median depth of domestic wells is 125 feet. The median depth of wells drilled for public, industrial, or other high-yield uses is 220 feet. Most domestic wells are 6 inches in diameter, and nondomestic wells range from 6 to 10 inches in diameter.

Casing is installed in wells to prevent surficial deposits and weathered bedrock from collapsing into the well bore and to prevent near-surface water from entering the well. Typically, steel casing is seated several feet into solid bedrock and the remainder of the well is completed as an open hole. Although most drillers prefer to complete domestic wells in bedrock, this is not always practical where thick saturated sand and gravel glacial deposits are present. In these areas, the well may be completed as an open-ended cased hole, or the lower part of the casing may be slotted. Where the glacial-outwash aquifer is tapped for high-yield purposes, screens and natural or artificial gravel packs typically are used.

The depth of a domestic well depends on the yield capabilities of the aquifer, depth to water-bearing zones, and, in some cases, depth to solid bedrock. Deep wells are drilled at low-permeability sites not only to penetrate additional water-bearing zones, but also to provide well-bore storage. A statistical summary of well and casing depths of domestic wells for the various geologic units is given in Table 8.

Casing depths are related to the susceptibility of the aquifer to weathering and to the thickness of surficial deposits. The deepest casing depths are found in the Keyser and Tonoloway Formations because these carbonate rocks have the greatest susceptibility to weathering. About one of every four wells in these formations requires more than 100 feet of casing. Wells drilled into the friable sandstone beds locally found at the top of the Old Port Formation may require deep casing to prevent well-bore collapse. A domestic well (Nu-251) in Riverside that penetrated 3 feet of water-bearing sand at depth required 76 feet of casing. About one of every four domestic wells in the Sherman Creek Member of the Catskill Formation requires more

Table 8. *Summary of Well and Casing Depths of Domestic Wells*

Aquifer	Well depth (feet below land surface)					Casing depth (feet below land surface)				
	Number of wells	75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Range	Number of wells	75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Range
Sand and gravel										
Glacial outwash	9	—	35	—	19–64	5	—	45	—	34–64
Sandstone and shale										
Mauch Chunk Formation	2	—	175	—	150–200	2	—	21	—	20–21
Catskill Formation	112	100	125	170	30–300	111	21	36	47	20–106
Duncannon Member	1	—	85	—	—	1	—	24	—	—
Sherman Creek Member	58	100	125	175	30–300	57	21	36	60	20–100
Irish Valley Member	53	100	130	165	50–275	53	20	40	44	20–106
Trimmers Rock Formation	67	123	197	275	35–523	53	20	22	39	16–81
Shale										
Harrell and Mahantango Formations	146	90	125	175	31–470	130	20	22	40	5–132
Marcellus Formation	40	71	87	123	50–285	36	20	30	42	11–71
Bloomsburg Formation	16	116	175	211	75–265	15	20	20	30	16–57
Carbonate rock and shale										
Onondaga and Old Port Formations	30	61	93	156	30–335	28	23	35	48	13–85
Wills Creek Formation	43	70	98	170	25–300	37	23	40	71	16–190
Carbonate rock										
Keyser and Tonoloway Formations	28	80	169	210	47–348	26	29	43	100	20–250
Sandstone, limestone, and shale										
Mifflintown, Keefer, and Rose Hill Formations	38	125	182	223	73–394	33	21	40	51	13–121
Mifflintown and Keefer Formations	7	—	125	—	73–315	7	—	36	—	20–50
Rose Hill Formation	31	128	189	223	—	27	20	41	51	13–121
Upper member	14	125	195	230	93–280	12	38	53	88	20–121
Middle and lower members	17	131	175	219	75–394	15	20	26	41	13–43

[1]Percentage of wells in which depth is equaled or exceeded.

than 60 feet of casing because of thick deposits of till overlying much of its outcrop area.

Some wells drilled through the Mifflintown and Keefer Formations into the upper member of the Rose Hill Formation penetrate abandoned iron-ore mines (Figure 6). Four wells that intersect iron-ore mines required 70 to 121 feet of casing. One well that hit a mine void at 160 feet was abandoned, as casing to that depth was considered to be impractical (Inners and Williams, 1983).

Difficulties may arise where drilling is done through glacial-outwash deposits and highly weathered carbonate rock using an air-rotary rig. Lost air circulation is a common problem in both types of rock. In the outwash deposits, isolated boulders, which are found interbedded with the finer grained deposits, can cause drilling problems. In highly weathered carbonate rock, "floating" boulders (solid rock surrounded by weathered materials) may be a source of difficulty. Where the outwash deposits are saturated, sand, silt, and clay may flow, making it difficult to keep the hole open. A common practice used when drilling sand and gravel and weathered rock is drilling and driving. The repetitious procedure involves drilling very short intervals of rock followed by driving the casing through the drilled interval; in some wells, the casing is driven ahead of the drilled interval.

WELL YIELD

Reported Yield

The reported yields presented in Tables 9 and 10 were, for the most part, determined by the driller on the basis of a short-term drillstem or bailer test when the well was completed. Reported yields based on drillers' completion tests appear to approximate the maximum short-term yield of the wells in most cases, but may not be accurate under certain conditions. In aquifers of high permeability, such as sand and gravel or carbonate rock containing solution cavities, much of the water may be forced back into the aquifer during a drillstem test rather than

Table 9. *Summary of Reported Yields of Domestic Wells*

Aquifer	Number of wells	Median well depth (feet below land surface)	Reported yield (gal/min) 75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Range
Sand and gravel	4	44	—	20	—	15–50
Shale	168	122	5	10	15	.5–50
Sandstone and shale	163	150	6	8	10	.5–60
Sandstone, limestone, and shale	31	191	5	10	20	2–50
Carbonate rock and shale	63	110	6	12	20	2–100
Carbonate rock	28	165	10	20	30	3–150

[1]Percentage of wells in which yield is equaled or exceeded.

Table 10. *Summary of Reported Yields of Nondomestic Wells*

Aquifer	Number of wells	Median well depth (feet below land surface)	Reported yield (gal/min) 75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Range
Sand and gravel	8	58	—	40	—	18–100
Shale	31	300	8	15	50	1–225
Sandstone and shale	19	300	20	32	64	3–100
Sandstone, limestone, and shale	7	305	—	93	—	10–300
Carbonate rock and shale	22	224	23	38	49	20–184
Carbonate rock	14	280	65	160	383	24–900

[1]Percentage of wells in which yield is equaled or exceeded.

pushed to the surface. In deep wells of low or moderate yield, drillers' completion tests may not be long enough to distinguish between well-bore storage and well yield.

Nondomestic wells, which include municipal, industrial, and commercial wells, generally have higher reported yields than domestic wells because (1) nondomestic wells commonly are deeper and penetrate more water-bearing zones; (2) a greater proportion of nondomestic wells are located in valleys, the topographic setting that generally has the highest yields; (3) the average diameter of nondomestic wells is greater; and (4) many of the higher domestic yields are underestimated because drillers commonly do not determine exact discharges for yields exceeding those considered adequate for household use.

Specific Capacity

A better measure of the yield capabilities of a well is its specific capacity. Specific capacity is the discharge of a well in gallons per minute per foot of drawdown [(gal/min)/ft] (Figure 10). Specific capacities can be determined from drillstem and bailer tests, as well as actual pumping tests. Specific capacities of wells reported by drillers on the basis of drillstem and bailer tests are presented in Table 23. The rate at which the well was blown or bailed is the reported yield. The specific capacities reported by drillers are considered to be rough estimates and were not used in relating well yields to various hydrogeologic factors.

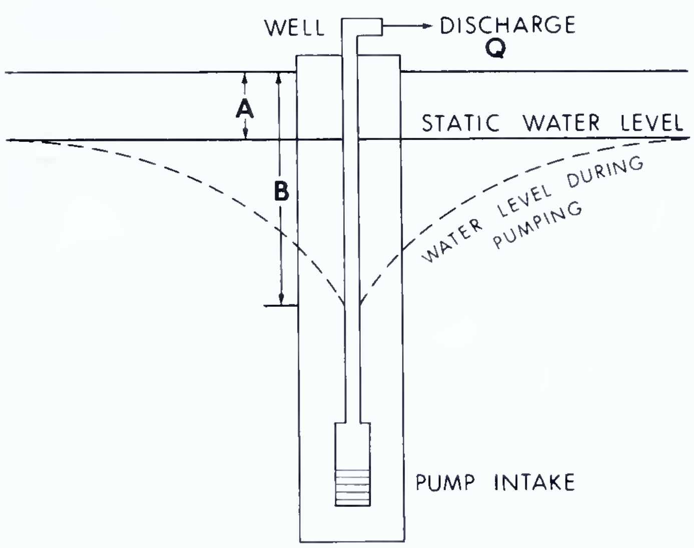
Pumping tests provide the most reliable data on specific capacity. One hundred fifteen wells were pump tested by drillers, consultants, and U.S. Geological Survey personnel. The specific capacities and the pumping rates and durations for these tests are given in Table 23. The specific-capacity data are summarized by aquifer in Table 11.

Effects of Pumping Rate on Specific Capacity

Variable-rate pumping-test data indicate that specific capacity decreases as the pumping rate increases. Specific capacity decreases with increasing pumping rate because of increases in well loss (i.e., frictional losses due to turbulence) and, in some cases, the lowering of the pumping water level during pumping below water-bearing zones. When the water level in a well is drawn below a producing zone, the zone becomes free flowing and is no longer progressively stressed by increasing drawdown. Any further increase in drawdown causes an increase in yield from lower zones only.

Figure 11 shows the results of variable-rate pumping tests on wells Nu-158 and Nu-187. In well Nu-187, the water levels associated with discharge rates of 16, 29, and 63 gal/min were above both producing zones. Decreases in specific capacity are attributed to aquifer and well losses only. About one third of the drawdown at 29 and 64 gal/min was due to these types of losses.

In well Nu-158, the pumping water level at a 24 gal/min pumping rate was above all of the water-bearing zones. Pumping at 60 gal/min drew the water level below the two shallowest zones at 22 and 30 feet. The pumping rate increase resulted in a 65



EXPLANATION

$$SC = \frac{Q}{B-A}$$

where
SC = Specific capacity, in gallons per minute per foot of drawdown
A = Depth to static water level, in feet below land surface
B = Depth to pumping water level, in feet below land surface
Q = Discharge, in gallons per minute

Figure 10. Schematic drawing of a pumping well and the equation for determining specific capacity.

Table 11. *Summary of Specific Capacities of Pump-Tested Wells*

Geologic unit or lithology	Number of wells	Median well depth (feet below land surface)	Specific capacity [(gal/min)/ft] 75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Range
Glacial outwash	10	66	3.7	11	19	1.4–84
Catskill Formation	15	165	.16	.39	1.2	.08–3.8
Sherman Creek Member	13	275	.14	.39	1.8	.08–3.8
Irish Valley Member	2	91	—	.44	—	.34–.53
Trimmers Rock Formation	8	200	.06	.13	.37	.03–.55
Harrell and Mahantango Formations	16	263	.06	.27	.79	.03–2.5
Marcellus Formation	15	255	.07	.19	.50	.03–18
Onondaga and Old Port Formations	13	259	1.2	3.2	9.3	.47–350
Keyser and Tonoloway Formations	18	205	1.6	4.6	20	.35–280
Wills Creek Formation	15	170	1.8	3.1	5.3	.23–18
Bloomsburg Formation	5	228	.09	.18	.50	.03–.64
Mifflintown and Keefer Formations	3	250	—	.13	—	.10–.37
Rose Hill Formation	8	266	.05	.21	1.1	.03–1.4
Upper member	4	264	.16	.71	1.3	.10–1.4
Middle and lower members	4	201	.04	.06	.62	.03–.80
Shale	35	268	.07	.23	.50	.03–18
Sandstone and shale	23	200	.12	.22	.55	.03–3.8
Sandstone, limestone, and shale	11	250	.07	.13	.80	.03–1.4
Carbonate rock and shale	28	202	1.5	3.1	5.5	.23–350
Carbonate rock	18	205	1.6	4.6	20	.35–280

[1]Percentage of wells in which specific capacity is equaled or exceeded.

percent reduction in specific capacity. At 75 gal/min, the water level was below all but the deepest producing zone. The decrease in specific capacity from the 60 to the 75 gal/min rate was 50 percent. Well-bore-flow tests during the pumping of well Nu–158 at 24 gal/min indicate that 75 percent of the well yield is produced by the water-bearing zones at 22 and 30 feet and 20 percent is produced by the zones at 88 and 108 feet (Figure 12).

The approximate doubling of discharge rate during pumping tests in 10 wells caused a 24 to 67 percent reduction in specific capacity (Table 12). The reduction in specific capacity for five wells in which the pumping water level fell below the water-bearing zone or zones ranged from 50 to 67 percent, and the median was 59 percent. The reduction in specific capacity for five wells in which aquifer and well losses were the only factors ranged from 24 to 41 percent, and the median was 38 percent.

Effects of Pumping Duration on Specific Capacity

Data from long-term pumping tests indicate that specific capacity decreases with increasing pumping time. The specific capacity of wells that are pumped continuously will decrease until (1) natural discharge from the groundwater system has been decreased by an amount equal to the pumping rate; (2) recharge to the groundwater system is increased by an amount equal to the pumping rate; or (3) the sum of decreased natural discharge and increased recharge equals the pumping rate (Carswell and Lloyd, 1979). Valleys, especially along the Susquehanna River and its major tributaries, are the best areas for decreasing natural discharge or inducing recharge from surface water. Upland areas near drainage-basin divides have the least amount of available water. The reduction of specific capacity after 24 hours of continuous pumping as

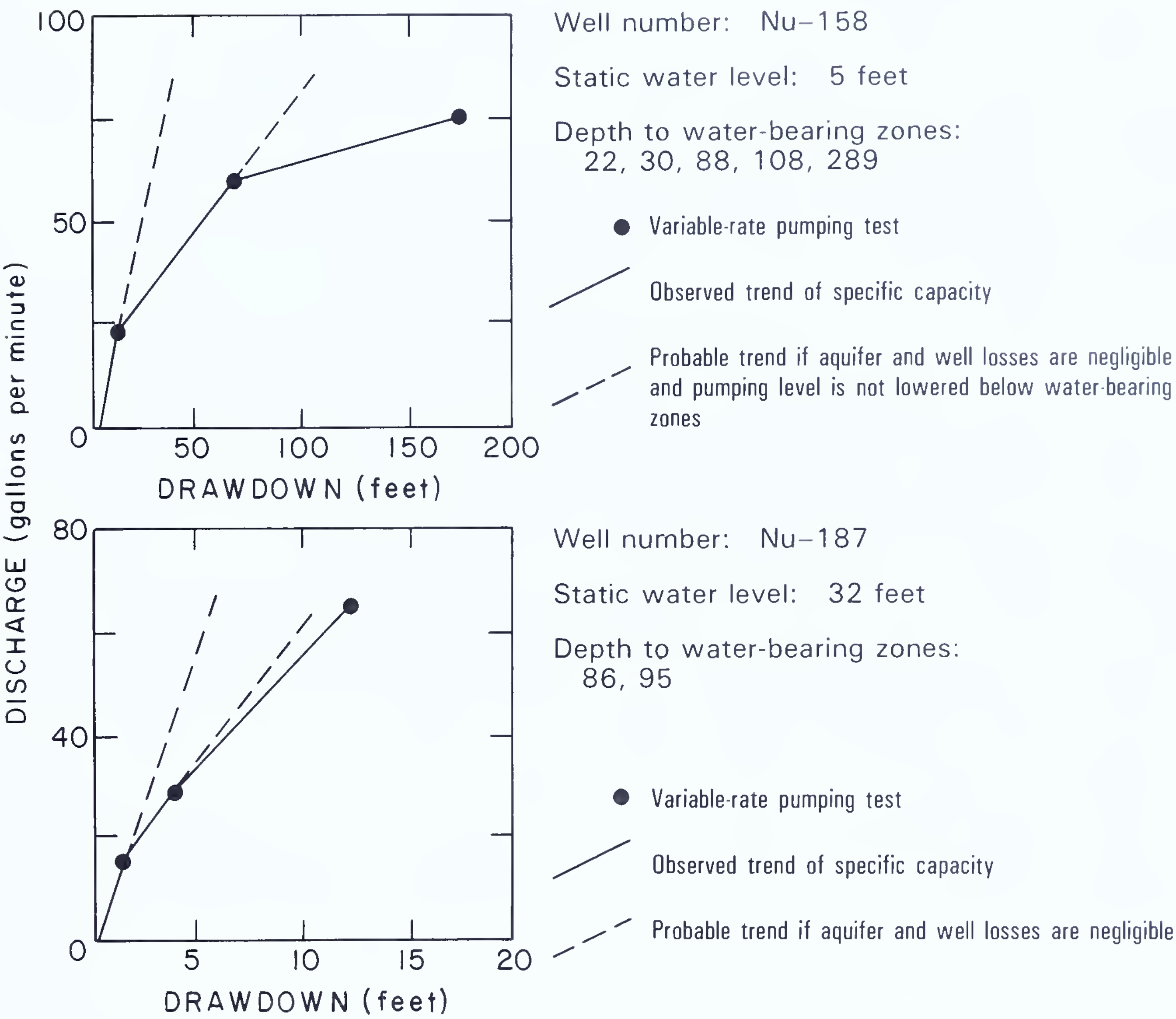


Figure 11. Variable-rate pumping tests of wells Nu–158 and Nu–187.

compared to 1-hour values in 15 wells ranged from 17 to 90 percent, and the median decrease was 38 percent (Table 13). On the average, about two thirds of the decrease in specific capacities occurred after 8 hours of pumping. Six wells pumped continuously for 48 hours had a median decrease in specific capacity of 12 percent from 24 to 48 hours.

Recovery

All domestic wells and most nondomestic wells are not pumped continuously but are shut off and allowed to recover between pumping periods. Recovery yield, the rate at which water flows into the well bore after pumping has stopped, is critical in low-yield domestic wells that depend on well-bore storage and in nondomestic wells that are pumped beyond their long-term capacity during peak-demand periods. Recovery yield was measured after the completion of pumping tests in 13 wells that tap noncarbonate-rock aquifers. The median recovery yield measured in the wells at 40 feet of residual drawdown was 7.5 gal/min. The median recovery yield divided by the residual drawdown (40 feet) is 0.19 (gal/min)/ft. This recovery "specific capacity" is comparable to median specific capacities calculated from pumping tests for the various noncarbonate rocks. Lack of sufficient recovery data prevented a similar comparison for the other aquifers.

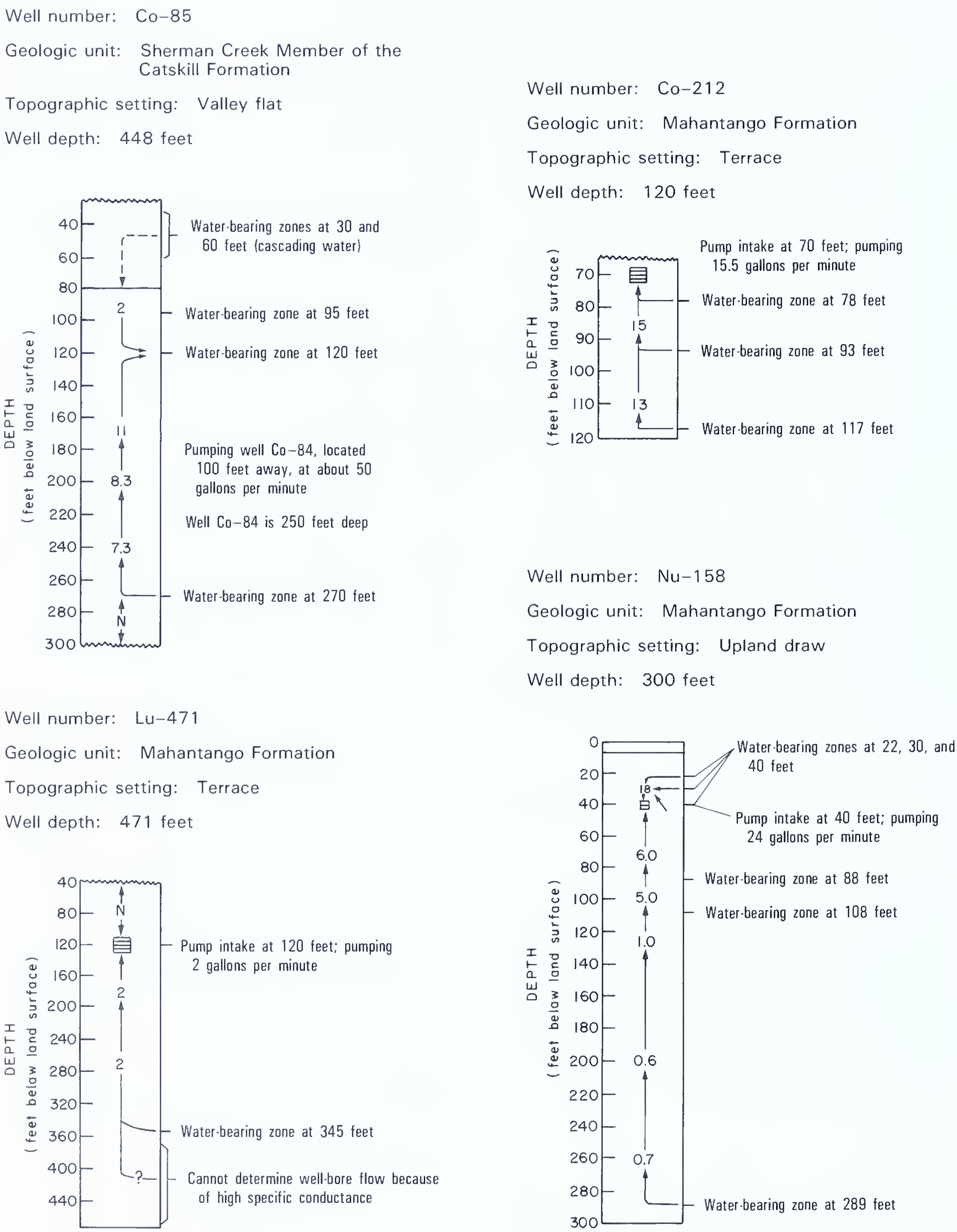


Figure 12. Well-bore flow in selected wells under pumping conditions. Arrows and numbers signify direction and rate of flow in gallons per minute; N indicates no measurable flow.

Table 12. *Reduction of Specific Capacity in Selected Wells with Increased Pumping Rate*

	Well number	Aquifer	Topographic setting	Lower pumping rate (gal/min)	Specific capacity at lower pumping rate [(gal/min)/ft]	Higher pumping rate (gal/min)	Specific capacity at higher pumping rate [(gal/min)/ft]	Percent reduction
Increased pumping rate caused water level to be drawn below water-bearing zone or zones.	Co-205	Wills Creek Formation	Terrace	77	2.2	136	1.1	50
	Co-209	Sherman Creek Member of Catskill Formation	Upland draw	7	.16	12	.06	62
	Mt-1	Tonoloway Formation	Valley flat	25	2.1	50	.69	67
	Mt-6	Upper member of Rose Hill Formation	Upland draw	50	1.4	110	.68	51
	Nu-158	Mahantango Formation	Upland draw	24	2.1	60	.87	59
				Median percent reduction = 59				
Increased pumping rate did not cause water level to be drawn below water-bearing zone or zones.	Co-52	Old Port Formation	Terrace	650	17	1,170	13	24
	Co-204	Wills Creek Formation	Terrace	85	12	140	7.4	38
	Co-307	Tonoloway Formation	Terrace	36	32	89	20	38
	Mt-2	Keyser Formation	Valley flat	100	13	200	7.7	41
	Nu-187	Keyser Formation	Terrace	16	11	29	7.3	34
				Median percent reduction = 38				

Table 13. *Reduction of Specific Capacity in Selected Wells with Increased Pumping Duration*

Well number	Aquifer	Topographic setting	Specific capacity [(gal/min)/ft] 1-hour	8-hour[1]	24-hour[1]	48-hour[1]
Co- 66	Sherman Creek Member of Catskill Formation	Upland draw	1.4	(51)	0.30 (72)	—
204	Wills Creek Formation	Terrace	11	9.6 (12)	9.0 (17)	7.8 (28)
207	Glacial outwash	do.	7.0	5.7 (19)	4.6 (35)	—
448	Old Port Formation	do.	25	9.0 (64)	2.6 (90)	—
505	Tonoloway Formation	do.	3.0	2.1 (30)	2.0 (34)	—
Lu-486	Glacial outwash	do.	28	21 (25)	18 (36)	16 (43)
Mt- 1	Tonoloway Formation	Valley flat	4.8	2.0 (58)	—	—
2	Keyser Formation	do.	20	12 (38)	10 (50)	8.3 (59)
4	do.	do.	12	7.1 (39)	5.0 (18)	—
6	Upper member of Rose Hill Formation	Upland draw	—	—	3.3	1.4
14	Keyser Formation	Valley flat	55	47 (15)	—	41 (25)
16	Old Port Formation	do.	6.5	5.9 (9)	5.3 (18)	—
18	do.	do.	1.1	.67 (39)	—	—
29	Lower member of Rose Hill Formation	Upland draw	—	.92	.80	.76
31	Keyser Formation	Valley flat	16	13 (20)	9.9 (38)	99.0 (44)
Nu-187	do.	do.	7.4	4.7 (36)	4.2 (43)	—

[1]Percent reduction from 1-hour specific capacity is in parentheses.

HYDROGEOLOGIC FACTORS AFFECTING WELL YIELDS

Water-Bearing Zones

The yield of a well depends largely on the size and number of water-bearing zones that it penetrates. As a well is drilled deeper and more water-bearing zones are penetrated, the yield of the well increases. In general, however, as well depth increases, the size of water-bearing zones decreases and the vertical distance between zones increases.

Figure 13 shows the distribution of water-bearing zones with depth for noncarbonate rocks, and for carbonate and interbedded carbonate and noncarbonate rocks. In general, the vertical spacing between water-bearing zones in noncarbonate aquifers is greater than that for aquifers that contain carbonate rock. In both groups of aquifers, the greatest number of producing zones is between 50 and 100 feet below land surface. Between 100 and 300 feet below land surface, the vertical spacing of water-bearing zones increases more rapidly with depth in aquifers containing noncarbonate rocks than in aquifers containing carbonate beds. In both groups of aquifers, the greatest vertical spacing—about one producing zone for every 200 feet of hole sampled—is between 400 and 600 feet below land surface. The difference in well-yield capabilities between noncarbonate and carbonate aquifers is attributed, in part, to the difference in the number and spacing of producing zones and, in part, to the greater size of openings in the solution-prone rocks.

Reported yields of individual water-bearing zones indicate a decrease in opening size with depth. The amount of decrease in opening size with depth is controlled by lithology. Yields of more than a few gallons per minute are uncommon for water-bearing

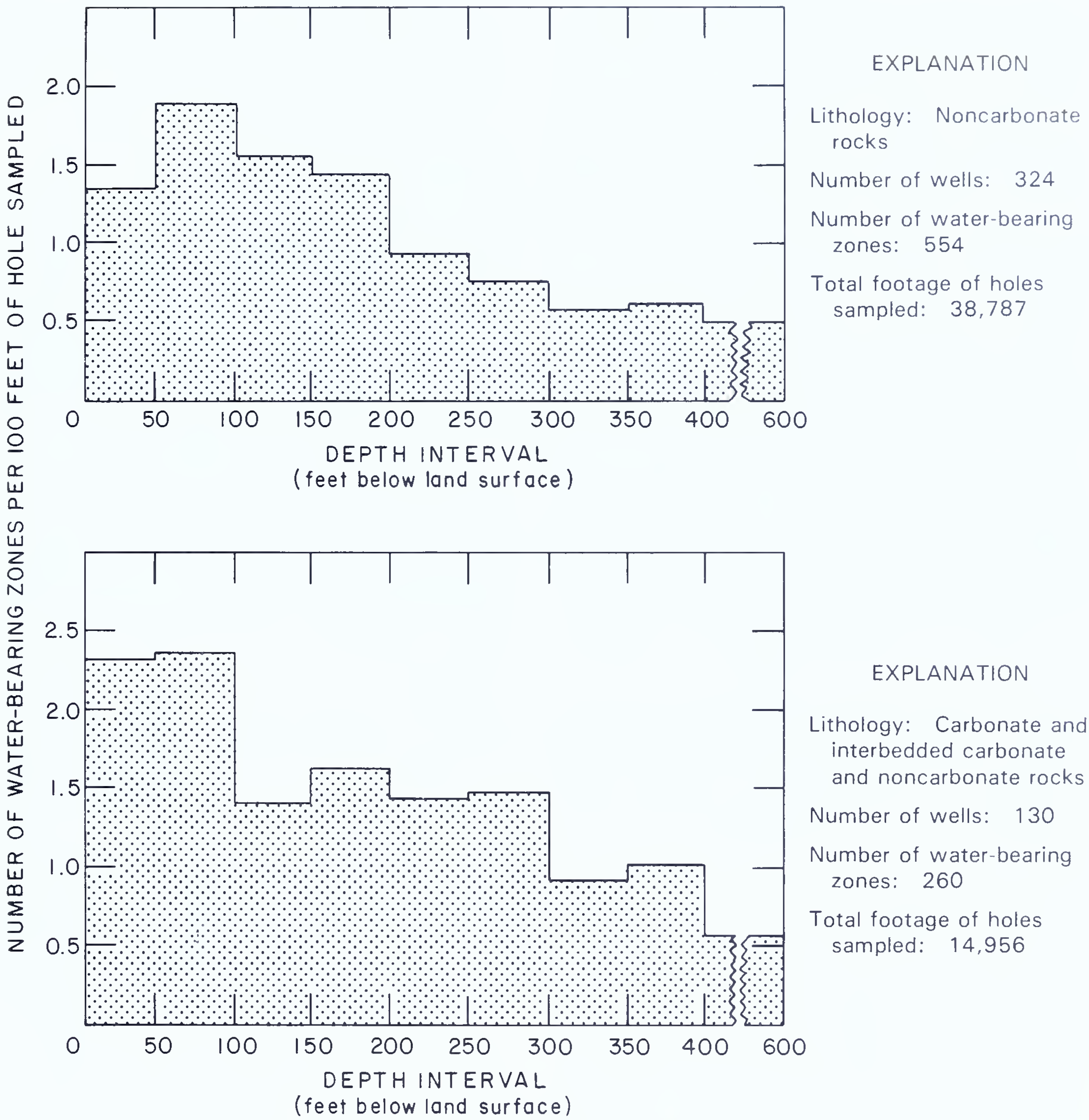


Figure 13. Distribution of water-bearing zones with depth.

zones below 300 feet in shale aquifers. Due to the more competent nature of coarse-grained beds, water-bearing zones remain more open to slightly greater depth in aquifers containing sandstones. Although one well reportedly penetrated a water-bearing zone having a yield of 40 gal/min at 450 feet, significant yields below 400 feet are believed to be uncommon in aquifers containing interbedded sandstone and shale.

Large yields may be obtained from deep zones in aquifers containing carbonate beds. In general, the limestones of the Keyser and Tonoloway Formations show the greatest yield capability at depth. In well Co-505, completed in the Tonoloway Formation near Lime Ridge, a water-bearing zone at a depth of 550 feet reportedly yielded over 200 gal/min.

Lithology

Lithology is a major factor controlling well yield. Wells completed in the glacial-outwash aquifer have

the highest specific capacities. Specific capacities of these wells range from 1.4 to 84 (gal/min)/ft and have a median value of 11 (gal/min)/ft. In bedrock aquifers, well yields are closely related to the amount of carbonate rock penetrated. Wells in the carbonate-rock sequence (Keyser and Tonoloway Formations) have a median specific capacity of 4.6 (gal/min)/ft. The interbedded carbonate rocks and shales of the Onondaga, Old Port, and Wills Creek Formations have the next highest median specific capacity, 3.1 (gal/min)/ft. Specific capacities of wells in the Mifflintown, Keefer, and Rose Hill Formations, composed mostly of shale and sandstone with some limestone, have a range of 0.03 to 1.4 (gal/min)/ft. In general, the noncarbonate-rock aquifers, including the shales of the Harrell, Mahantango, Marcellus, and Bloomsburg Formations and the interbedded sandstones and shales of the Catskill and Trimmers Rock Formations, have specific capacities an order of magnitude less than those for the carbonate-rock aquifer.

Topography

Topographic position is a significant factor that affects well yield. Wells in valleys generally have the highest yields and wells on hilltops have the lowest (Table 14). The median specific capacity for wells in valleys is 3 to 24 times greater than the median for wells on hilltops. Wells on slopes show specific capacities between those for wells in valley and hilltop settings.

Table 14. ***Median Specific Capacities of Wells by Topographic Setting***

Aquifer	Median specific capacity [(gal/min)/ft]		
	Hilltop[1]	Slope[1]	Valley[1,2]
Shale	0.10 (3)	0.17 (6)	0.31 (26)
Sandstone and shale	.04 (3)	.18 (7)	.39 (13)
Sandstone, limestone, and shale	.04 (2)	.10 (5)	.95 (4)
Carbonate rock and shale	.34 (1)	1.8 (3)	3.4 (24)
Carbonate rock	1.7 (1)	4.9 (1)	6.0 (16)

[1]Number of wells is in parentheses.
[2]Includes valley flat, terrace, and upland draw settings.

Differences in well yield among topographic settings are related to several factors: (1) valleys commonly are zones of more intense fracturing; (2) hydraulic gradients are toward valleys, and large volumes of water pass through these settings before being discharged; and (3) greater saturated thicknesses of sand and gravel in valleys provide for more recharge, storage, and transmission of water to underlying bedrock aquifers.

Fracture Traces

Fracture traces are natural linear features visible on aerial photographs that possibly are surface expressions of zones of fracture concentration in the underlying bedrock. They generally consist of topographic, vegetational, and soil-tonal alinements. Hydrogeologists in some areas have reported that wells drilled on fracture traces have higher yields than randomly located wells (Lattman and Parizek, 1964).

Specific capacities of wells intentionally located on fracture traces by hydrogeologists were compared with the median specific capacity for all wells located in the same hydrogeologic settings (Table 15). Only six of the 12 wells located on fracture traces had specific capacities greater than the corresponding median value. These data suggest that only a certain proportion of the linear features that were mapped on aerial photographs as fracture traces were actually underlain by zones of fracture concentration. Inaccurate field location may also

Table 15. ***Comparison of the Specific Capacities of Wells Located on Fracture Traces with the Specific Capacities of All Wells in the Same Hydrogeologic Settings***

Hydrogeologic setting[1]	Fracture-trace wells: Well number	Fracture-trace wells: Specific capacity [(gal/min)/ft]	Median specific capacity of all wells in hydrogeologic setting
Carbonate rock; valley	Mt- 1	0.70	6.0
	2	7.7	
	14	41	
	15	1.1	
	31	23	
Carbonate rock and shale; valley	Mt- 16	5.3	3.2
	17	2.7	
	32	.47	
Shale; valley	Mt- 30	.07	.31
	Nu-158	.87	
Shale; slope	Nu-157	1.2	.15
Sandstone, limestone, and shale; valley	Mt- 29	.80	.95

[1]"Valley" includes valley flat, terrace, and upland draw settings.

account for the lack of success at some fracture-trace sites.

ESTIMATED WELL YIELD

Table 16 shows estimated 24-hour well yields for the aquifers. The well yields were estimated from data on specific capacity, depth to water-bearing zones, and water levels. Specific capacities were adjusted to a common 24-hour pumping period based on the data in Table 13. The adjusted specific capacities were multiplied by the median available drawdown for each aquifer to obtain the estimated well yield. Available drawdown was defined as the difference in depth between the static water level and the shallowest water-bearing zone.

WELL INTERFERENCE

When the cones of depression of closely spaced pumped wells overlap, one well is said to interfere with another because of the increased drawdown that occurs in each well. The amount of interference is largely dependent on the degree of hydraulic connection between the water-bearing zones tapped by the wells, which varies widely from site to site. Data collected during this study, however, reveal the importance of bedding-related permeability in well-interference problems in bedrock aquifers.

The total yield of a group of closely spaced wells that are pumped simultaneously may be significantly less than the sum of yields of the individual wells that make up the well field. A good example of this type of interference problem is found at the Catawissa Water Authority well field. The pumping of well Co-84 at 50 gal/min causes 13 gal/min of cumulative well-bore flow in well Co-85, located about 100 feet away (Figure 12). The wells are connected by a common water-bearing zone penetrated in well Co-85 at 120 feet below land surface. Simultaneous pumping of these two wells significantly decreases their individual yields.

Table 17 shows the results of multiple-well pumping tests conducted by drillers, consultants, and

Table 16. *Estimated 24-Hour Well Yields of the Aquifers*

Aquifer	Median available drawdown[3]	Estimated well yield[1] (gal/min)		
		75 Percent[2]	50 Percent[2] (median)	25 Percent[2]
Sand and gravel				
Glacial outwash	26	58	190	410
Sandstone and shale	42	5	10	16
Catskill Formation	41	5	10	36
Sherman Creek Member	43	5	11	50
Irish Valley Member	41	—	11	—
Trimmers Rock Formation	43	—	5	—
Shale	42	2	7	15
Harrell and Mahantango Formations	39	1	7	22
Marcellus Formation	47	3	8	23
Bloomsburg Formation	46	—	6	—
Carbonate rock and shale	38	46	100	210
Onondaga and Old Port Formations	33	40	91	310
Wills Creek Formation	40	47	99	130
Carbonate rock				
Keyser and Tonoloway Formations	44	47	180	620
Sandstone, limestone, and shale				
Mifflintown, Keefer, and Rose Hill Formations	70	3	10	56

[1]Based on specific-capacity data adjusted to 24-hour pumping period and median available drawdown.
[2]Percentage of wells in which yield is equaled or exceeded.
[3]Based on data on depth to water-bearing zones and water levels.

Table 17. *Results of Multiple-Well Pumping Tests*

Length of test (hours)	Pumped well	Pumping rate (gal/min)	Drawdown (feet)	Observation well	Drawdown (feet)	Distance (feet)	Observation well	Drawdown (feet)	Distance (feet)	Remarks
						Glacial outwash				
6	Co-305	38	3.7	Co-311	0.5	117	Co-309	0.2	444	Aquifer for well Co-309 is Marcellus Formation.
3.5	Lu-455	36	2.9	Lu-454	1.0	9	—	—	—	Aquifer for well Lu-454 is Mahantango Formation.
8.5	Lu-491	150	22	Lu-450	5.4	—	Lu-490	5.9	100	Aquifer for well Lu-450 is Mahantango Formation.
						Catskill Formation				
3.5	Co-49	45+	38	Co-61	3±	90	Co-62	5.4	144	
2	Co-61	11	90	Co-49	1.0	90	Co-62	4.4	89	
48	Co-139	40	276	Co-140	68	350	—	—	—	Well Co-140 is 60 feet higher in altitude at ground surface than well Co-139.
48	Co-140	55	252	Co-139	74	350	—	—	—	
						Mahantango Formation				
3	Lu-454	9.7	75	Lu-455	.2	9	—	—	—	Aquifer for well Lu-455 is glacial outwash.
2	Mt-178	15	50	Mt-153	.9	385	—	—	—	
2	Nu-157	18	15	Nu-185	2.3	390	—	—	—	
40	Nu-158	60	70	Nu-157	1±	423	Nu-159	1+	292	
				Nu-180	14	787	—	—	—	
						Marcellus Formation				
24	Mt-30	20	284	Mt-31	.3	400	Mt-32	.4	530	Aquifer for well Mt-31 is Keyser Formation; aquifer for well Mt-32 is Old Port Formation.
						Onondaga and Old Port Formations				
24	Mt-16	160	30	Mt-17	14	15	—	—	—	
24	Mt-17	120	45	Mt-16	12	15	—	—	—	
24	Mt-32	73	155	Mt-30	.9	130	Mt-31	None	530	Aquifer for well Mt-30 is Marcellus Formation; aquifer for well Mt-31 is Keyser Formation.
28	Co-448	200	90	Co-441	1.3	500	Co-447	None	1,100	Aquifer for well Co-447 is Tonoloway Formation.
24	Co-505	290	123	Co-441	None	600	Co-447	None	1,000	Aquifer for well Co-448 is Old Port Formation.
				Co-448	<1	190	—	—	—	
3	Co-307	36	1.1	Co-308	.1	258	—	—	—	Aquifer for well Co-308 is glacial outwash.
						Keyser and Tonoloway Formations				
48	Mt-1	50	63	Mt-2	1.5	182	—	—	—	
72	Mt-2	200	26	Mt-1	20	182	—	—	—	
40	Mt-3	250	60	Mt-1	6.0	183	—	—	—	
2.3	Nu-187	16	1.4	Nu-188	.4	60	Nu-189	None	80	
24	Nu-187	63	15	Nu-191	.8	100	—	—	—	Aquifer for well Nu-191 is glacial outwash.
2	Nu-188	12	13	Nu-187	.4	60	Nu-189	None	30	
						Wills Creek Formation				
48	Co-204	140	19	Co-205	1.6	201	—	—	—	
48	Co-205	136	125	Co-204	1.5	201	—	—	—	
5	Co-571	175	16	Co-580	2.0	24	Co-581	.3	34	
				Co-582	1.9	64	Co-583	.4	66	
						Rose Hill Formation				
4.3	Mt-29	70	65	Mt-123	40	460	Mt-124	None	330	Well Mt-123 is 40 feet higher in altitude at ground surface than the other wells.

U.S. Geological Survey personnel. If the aquifers were ideal aquifers (isotropic, homogeneous, and areally extensive), drawdown would decrease symmetrically and logarithmically away from the pumped well. However, drawdowns measured in observation wells during pumping tests were erratic, especially in the bedrock aquifers. The relatively low storage capabilities and discrete nature of permeability in the bedrock aquifers cause large differences in drawdown between wells that are in hydraulic connection with the pumped well and wells that are not in hydraulic connection with the pumped well. Drawdown in observation wells having good hydraulic connection with the pumping well may approach that observed in the pumping well, whereas little to no observable drawdown occurs in those wells that are poorly connected.

Saturated sand and gravel generally behaves more like an ideal aquifer than does fractured bedrock. Departure from ideal conditions in the glacial-outwash aquifer is largely caused by variations in the thickness of saturated sand and gravel. Test drilling shows that the thickness of the saturated sand and gravel can change from more than 50 feet to zero within several hundred feet. Drawdowns from a hypothetical pumping well in the outwash aquifer were simulated using the 2-D, finite-difference model of Trescott and others (1976) under some typical hydrologic conditions. Actual drawdown would depart from simulated drawdown depending on the nonhomogeneity and anisotropy of the aquifer and the presence of recharge or impermeable boundaries.

Simulated drawdowns after 48 hours of pumping in the glacial-outwash aquifer are as follows:

		Drawdown (feet)			
			Distance from pumped well (feet)		
Pumping rate (gal/min)	Hydraulic conductivity (ft/day)	At pumped well	35	100	250
50	100	10	4.0	1.4	0.1
100	100	24	8.4	2.8	.3
100	200	11	5.1	2.2	.4
200	200	30	11	4.4	.8

Saturated thickness = 40 feet.
Specific yield = 0.15.

The simulated drawdowns are in the range observed during the limited number of tests conducted on the outwash aquifer.

During multiple-well pumping tests in the bedrock aquifers, significant interference was observed only between wells that tapped at least part of the same stratigraphic interval. Maximum well interference observed during pumping tests 4 to 72 hours long in the various lithologies was as follows:

	Pumped well		Observation well	
Lithology	Pumping rate (gal/min)	Drawdown (feet)	Drawdown (feet)	Distance from pumped well (feet)
Shale	60	70	14	787
Sandstone and shale	55	252	74	350
Sandstone, shale, and limestone	75	65	40	460
Carbonate rock and carbonate rock and shale	200	26	20	180

The observation wells that showed the maximum interference occurred updip, downdip, or along strike from the pumping well. However, in each case, the observation well tapped some of the same beds as the pumping well. This observation reemphasizes the importance of bedding-related permeability in the bedrock.

Individual water-bearing zones developed along selected beds can be recognized over significant distances along strike in the bedrock aquifers. Well interference problems will occur between wells that tap these zones. A good example is found at the Champion Valley Farms well field at Lime Ridge. Well Co–448 is located about 900 feet west of the Champion Valley Farms well field (wells Co–197, Co–198, and Co–199), which is pumped at a rate of about 350 gal/min for 5.5 days per week. The pumping of the well field causes significant drawdown in well Co–448, as shown in Figure 14. Calcareous chert beds yielding about 200 gal/min were penetrated in well Co–448 at depths of 142 and 152 feet below land surface. Although well Co–448 was drilled to 180 feet, the well bore collapsed at the deeper water-bearing cavern at 152 feet. In the driller's log for well Co–199, water-bearing zones were indicated at 170 and 180 feet. Reportedly, well interference occurs between wells Co–198 and Co–199. According to the driller's log, well Co–108 penetrated water-bearing caverns at 120 and 130 feet below land surface. Well Co–108 is located 1,250 feet east of the well field. Wells Co–108, Co–198, Co–199, and Co–448 probably tap the same water-bearing zones developed along two solution-prone, calcareous chert beds in the Old Port Formation for a distance of more than 2,000 feet along bedding strike. Well Co–448 showed a 90 percent reduction in specific capacity from 1 to 24 hours of pumping, the largest reduction observed in all pumping

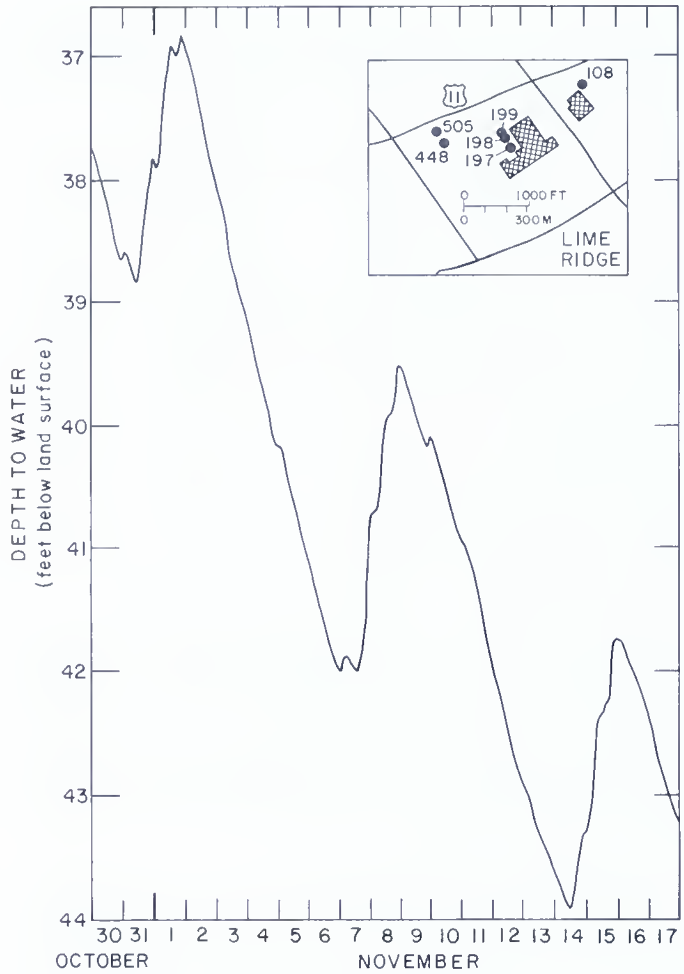


Figure 14. Water-level fluctuations observed in well Co-448 in response to nearby industrial pumping, October 30 to November 17, 1981.

tests. At least part of this decreased capacity caused by lowered water levels can be attributed to interference from pumping at wells Co-198 and Co-199.

It is worthwhile to note that negligible drawdown occurred in well Co-448 during the pumping of well Co-505 at 290 gal/min. Well Co-505 is about 190 feet across bedding strike from well Co-448 and is completed in the Keyser and Tonoloway Formations. The water level in well Co-505 does not appear to be affected by pumping of wells Co-198 and Co-199, even though it is at nearly the same distance from the pumping wells as is well Co-448.

Assuming a bedding dip of 35 degrees, flat topography, and well depths of 400 feet, wells located more than 500 feet across bedding strike typically will not show significant interference (Figure 15). Where bedding dips are more shallow, such as on the noses of major folds, well interference may occur at greater distances across bedding strike. In addition, where steep topographic gradients parallel bedding dip, such as along the flanks of Montour Ridge and its eastern extension, interference may occur between wells located across strike at significant distances.

Well interference has been observed in two areas along the southern flank of the ridge about 1.5 miles east of Danville between nondomestic wells that tap deep, confined water-bearing zones in the Mifflintown, Keefer, and Rose Hill Formations and domestic wells located in an updip direction (Figure 16). In one area, when a deep, nondomestic well (Mt-29) was allowed to flow at 75 gal/min for about 4 hours, 40 feet of drawdown was observed in a domestic well (Mt-123) located about 460 feet updip of well Mt-29. No drawdown was observed during the test in another domestic well (Mt-124) located about 300 feet downdip. In a nearby area, the pumping of the Mahoning Township Water Authority well field (wells Mt-5 and Mt-6) affected water levels in two updip domestic wells located up to 700 feet away. No downdip wells were known to be affected.

The hydraulic connection between the bedrock and glacial-outwash aquifers largely depends on the amount of fracturing in the rock that separates water-bearing zones in the bedrock from the saturated sand and gravel. If a bedrock well penetrates water-bearing zones that intersect the bedrock-unconsolidated rock contact, pumping of the well can cause significant drawdown in wells completed in the glacial-outwash aquifer. An example of good interconnection of the glacial-outwash and bedrock aquifers is shown in Figure 17. Test hole Co-154, completed in glacial outwash and till, and well Co-310, completed in carbonate bedrock, display similar water-level fluctuations caused by the pumping of an industrial well field completed in the carbonate-rock aquifer located, respectively, about 4,000 and 2,500 feet away.

WATER-QUALITY CHARACTERISTICS OF THE AQUIFERS

PHYSICAL CHARACTERISTICS

Temperature

The temperature of groundwater is affected by the geothermal gradient, groundwater flow paths, air temperature, and, to a limited extent, the return of water used for air conditioning. The temperature of discharge water was measured from 85 wells sampled for laboratory analyses. In addition, temperature logs were run on 39 wells ranging in depth from 68 to 558 feet (Table 2).

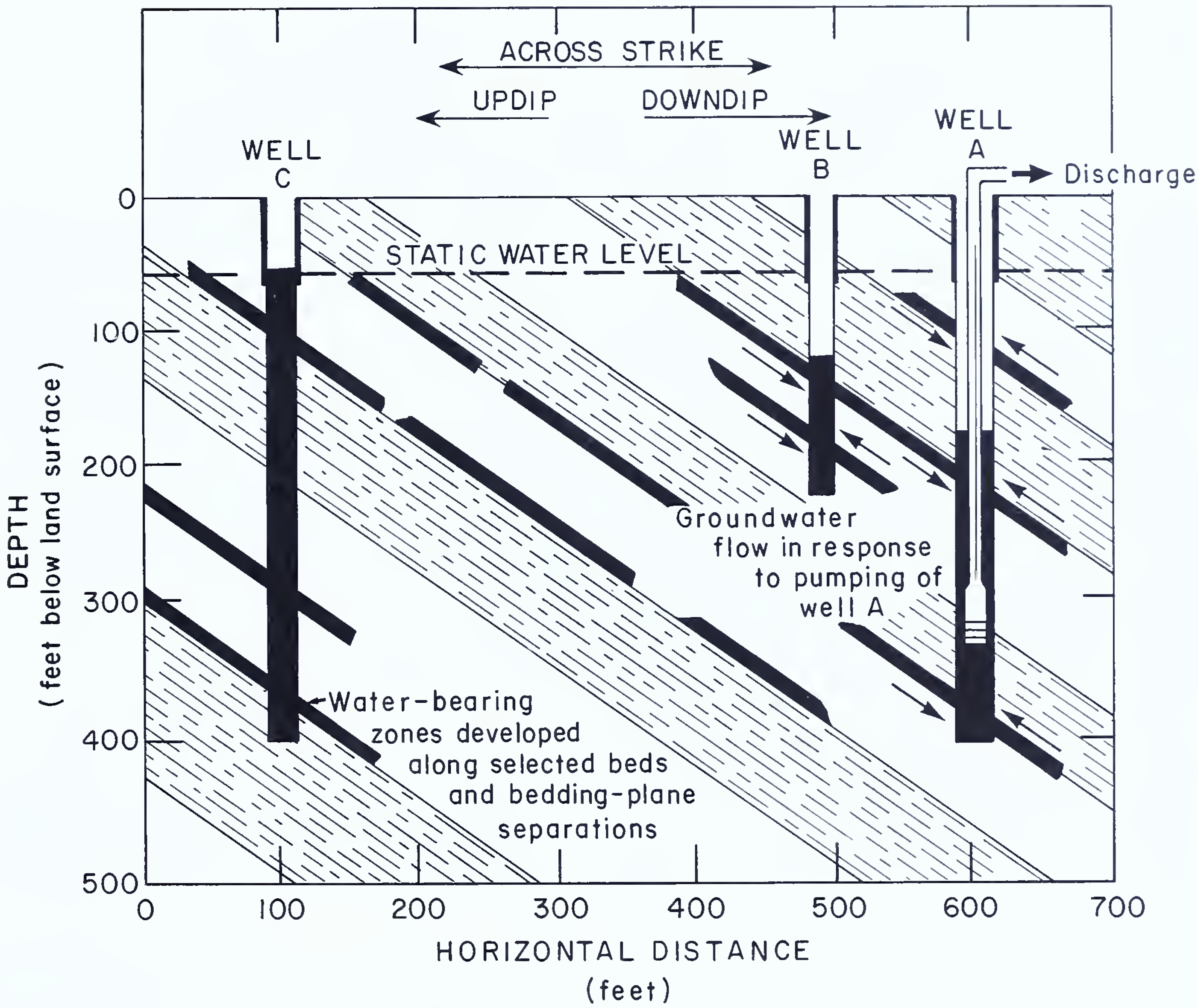


Figure 15. Relationship among well spacing, bedding-related permeability, and groundwater flow in response to pumping.

The temperature of groundwater discharged by wells ranged from 51 °F to 59 °F, and the median was 54 °F. The temperature of water discharged from a well is largely dependent on the depth and relative yield of the water-bearing zones that it penetrates. Deeper zones typically produce warmer water than shallow zones due to the effect of the geothermal gradient. The geothermal gradient, as determined from temperature logs in wells at depths having minimal flow, is about 1 °F per 100 feet. For example, well Co-505, which has a major water-bearing zone at 550 feet, produces water having a temperature about 3 °F warmer than the median value for all wells.

Figure 18 shows temperature logs for wells Co-245, Co-452, and Co-505. A composite temperature log based on median values computed at 50-foot intervals for 26 deep wells also is presented. The slope of the composite temperature gradient approaches that of the geothermal gradient below 300 feet. This indicates the lack of significant groundwater flow below 300 feet in most aquifers.

Well Co-452 provides an example of a temperature log representing typical hydrologic conditions. Flow in the well bore between water-bearing zones and, to some limited degree, in the aquifer itself masks the geothermal gradient in the upper 300 feet of the temperature log. Below this depth, the temperature gradient of water in the well bore is controlled by the geothermal gradient.

In wells that have flow between shallow and deep water-bearing zones, the effects of the geothermal gradient on the temperature of water in the well bore may be dampened. Downward flow moves colder water from shallow zones down the well bore, and upward flow moves warmer water from

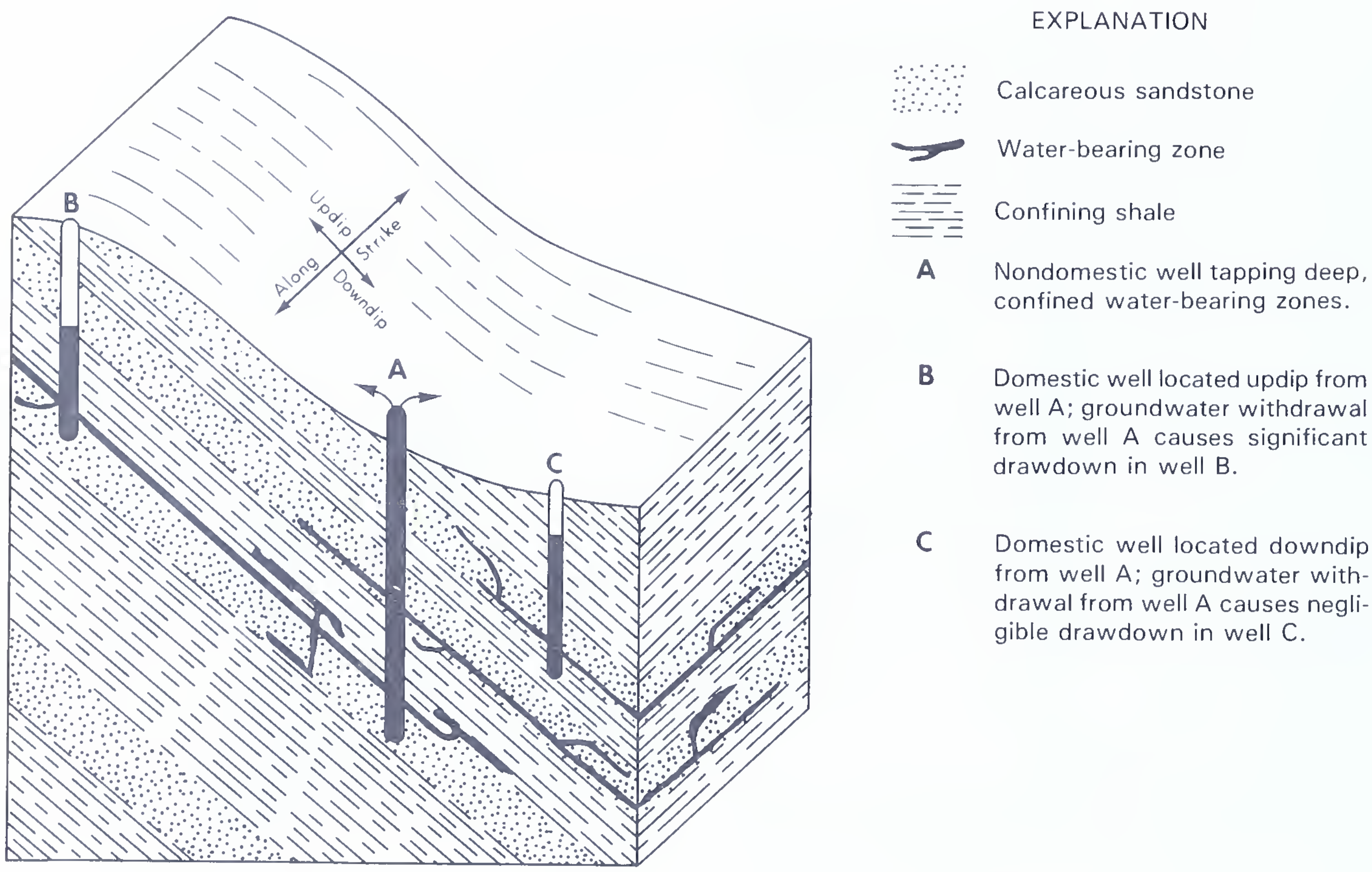


Figure 16. Hydrologic relationship between wells completed in the Mifflintown, Keefer, and Rose Hill Formations along the flanks of Montour Ridge and its eastern extension between Danville and Bloomsburg.

deep zones up the well bore. The temperature gradients for the depth interval of 300 to 400 feet measured in well Co-245 (downward flow) was 0.4 °F per 100 feet and in well Co-505 (upward flow) was 0.1 °F per 100 feet.

Lloyd and Growitz (1977) found that in York County the temperature of shallow groundwater varied with seasonal changes in air temperature. Carswell and Lloyd (1979) found that in Monroe County the temperature of groundwater at about 300 feet below the water table varied with the average annual air temperature. Although sufficient temperature data are unavailable in this area, similar relationships between groundwater and seasonal and average-annual air temperatures are believed to exist in the Berwick-Bloomsburg-Danville area.

The temperature of groundwater also may be affected by the return of water used for cooling to an aquifer. The only well known to be used for the return of cooling water is well Co-69 in Berwick. During the summer, groundwater is pumped from well Co-68 at a rate of about 200 gal/min and is used for air conditioning. The warm water is then returned to the aquifer by well Co-69.

No groundwater heat pumps are known to be in operation in the study area, although there is good potential for the development of this alternative energy source. Groundwater heat pumps extract heat from well water using a refrigeration system. During the summer, the system may be reversed, and the heat pump can be used for cooling. The well yield typically needed for a groundwater heat pump, 5 to 15 gal/min, can be found in most local hydrogeologic settings. In settings where a sufficient yield may not be obtainable, such as on a hilltop underlain by sandstones and shales, more efficient heat pumps requiring less than 5 gal/min could be used.

Turbidity

Turbidity is a cloudiness in water caused by suspended material such as sand, silt, clay, or colloidal precipitates of iron or manganese. In most cases, turbidity in water produced from bedrock aquifers is negligible after wells have been developed. Turbidity may be a problem in wells that tap glacial deposits, where casing does not adequately seal water from overlying unconsolidated

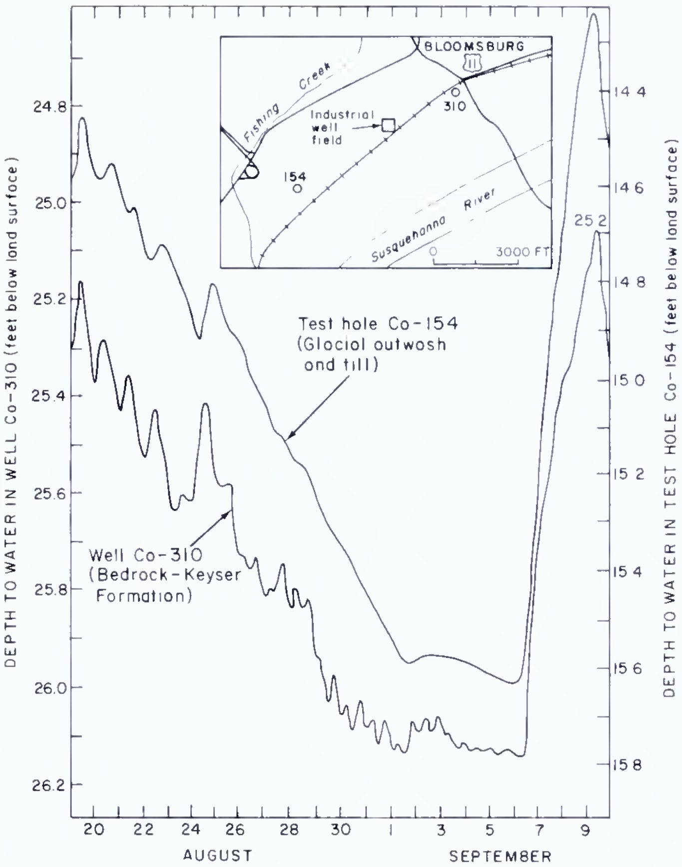


Figure 17. **Effects of industrial pumping on water levels observed in test hole Co-154 and well Co-310 at Bloomsburg, August 19 to September 9, 1981.**

material, or where mud-filled solution zones are present in bedrock. As an example, well Mt-2, completed in the solution-prone Keyser Formation, had to be abandoned because of a recurring problem of suspended clay.

Dewatering of a water-bearing zone may cause a well that normally produces clear water to yield turbid water. The turbidity may be related to the drying and sloughing of clay and oxide coatings along dewatered fractures. Two wells have shown turbidity attributable to dewatering effects. Well Co-157 developed a turbidity problem during a period of low water levels in the early winter of 1980, but the turbidity cleared as water levels rose in February 1981. In well Nu-180, the water level dropped 14 feet during a 48-hour pumping test at a nearby well and turbid water was noticed; the turbidity persisted in well Nu-180 for several days after the pumping test ended.

Domestic wells drilled in glacial outwash commonly use open-ended casing, and fine particulate matter may be suspended in water from some of these wells. The use of well screens and gravel packs tends to prevent turbidity in properly developed wells in glacial outwash.

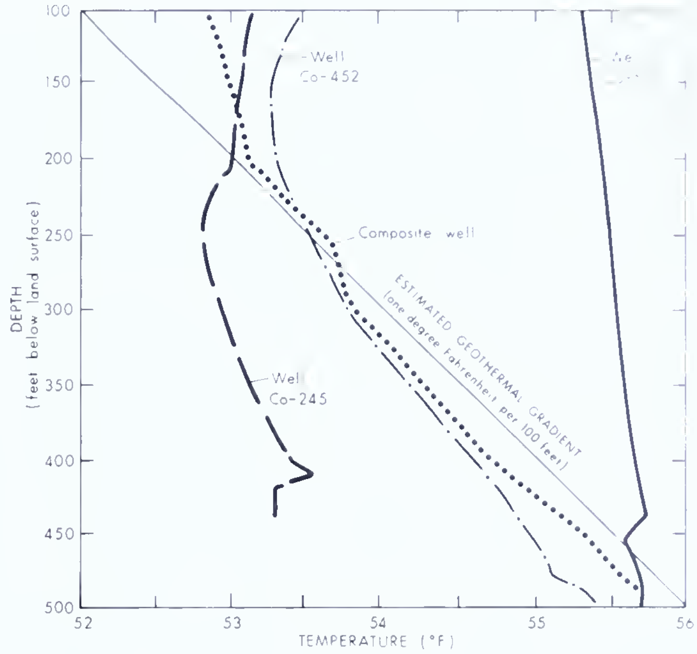


Figure 18. **Temperature logs of selected wells, a composite log based on median values for 26 wells, and the estimated geothermal gradient.**

Wells Co-154 and Co-308 in glacial outwash yielded groundwater having a black-colored turbidity. The source of the turbidity is probably particulate coal that enters the slotted casing during pumping. These wells were installed as observation wells and were not developed for water-supply use.

CHEMICAL CHARACTERISTICS

The chemical quality of groundwater in the Berwick-Bloomsburg-Danville area was evaluated on the basis of field determinations of specific conductance and hardness of water from 299 wells and laboratory chemical analyses of water from 139 wells. Field values of specific conductance and hardness are presented in Table 23. Results of the laboratory chemical analyses for major ions, metals, nutrients, and other common parameters are reported in Table 21. Most of the chemical analyses were done by the U.S. Geological Survey Laboratory in Doraville, Georgia, but data from other laboratory sources were used selectively. Additional analyses for selected trace metals and organic compounds were made on water from 18 wells (Table 22). The groundwater-quality data are summarized by aquifer in Tables 18 and 19.

In general, groundwater in the study area is mainly of the calcium bicarbonate type. The calcium bicarbonate water occurs in the glacial-outwash and shallow bedrock aquifers (generally less than 300 feet deep) where there is active circulation of

Table 18. *Median Concentrations of Selected Dissolved Constituents in the Aquifers*

(Concentrations are in milligrams per liter except where otherwise indicated)

Aquifer	Number of samples	Silica (SiO_2)	Iron (Fe) (µg/L)	Manganese (Mn) (µg/L)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate+nitrite (NO_3+NO_2, as N)	Orthophosphate (PO_4, as P)	Dissolved solids	Hardness ($CaCO_3$) Calcium and magnesium	Hardness ($CaCO_3$) Noncarbonate	Alkalinity ($CaCO_3$)
Glacial outwash	7–11	12	250	475	13	3.8	6.7	1.3	32	5.0	0.1	0.2	0.01	95	49	26	19
Mauch Chunk Formation	1	5.7	10	1	1.6	.7	.4	.2	.7	.6	.1	.3	.01	15	7	0	7
Catskill Formation	19–23	12	220	28	12	4.0	5.4	.6	3.4	6.4	.1	1.9	.01	93	50	12	33
Sherman Creek Member	12–16	11	175	10	14	3.4	5.8	.6	11	7.0	.1	2.4	.02	98	56	14	36
Irish Valley Member	7	16	260	90	3.4	4.7	5.4	.6	1.4	4.4	.1	.1	.01	63	28	1	16
Trimmers Rock Formation	8	13	63	35	7.8	50	4.4	.5	8.2	3.9	.1	1.6	.01	78	42	11	24
Harrell and Mahantango Formations	18	14	660	55	24	3.8	8.6	.6	16	4.4	.1	.1	.01	144	76	7	56
Marcellus Formation	6–7	16	1,100	180	41	10	12	.9	46	23	.1	.02	.01	265	160	22	130
Onondaga and Old Port Formations	3–8	7.3	510	5	56	18	15	2.1	48	20	.1	3.8	.01	301	185	54	118
Keyser and Tonoloway Formations	8–13	11	110	6	70	20	10	1.2	78	20	.1	.9	.01	374	240	102	140
Wills Creek Formation	8–12	8.4	25	8	38	12	5.3	.6	19	18	.1	2.9	.01	196	130	44	108
Bloomsburg Formation	10–11	9.6	280	30	22	5.4	3.7	.7	20	5.2	.1	2.2	.09	125	77	23	43
Mifflintown and Keefer Formations	7	8.1	37	38	22	4.7	5.4	.5	16	9.0	.1	.6	.01	135	79	19	84
Rose Hill Formation	15–17	7.4	85	125	21	9.9	2.5	.6	8.9	1.6	.2	.08	.01	100	91	8.0	81
Upper member	4–5	9.5	28	7	21	4.2	4.0	.3	12	4.1	.2	.04	.01	90	84	18	75
Middle and lower members	11–12	7.0	360	160	17	10	1.3	.8	6.3	1.5	.2	.1	.01	100	91	7	93
Recommended limit (U.S. Environmental Protection Agency, 1976a, b)		—	300	50	—	—	250	—	250	250	1.7	10	—	500	—	—	—

Table 19. *Summary of Field Measurements of Specific Conductance and Total Hardness in the Aquifers*

Aquifer	Specific conductance (μmho/cm at 25°C)				Total hardness (mg/L as $CaCO_3$)			
	Number of samples	75 Percent[1]	50 Percent[1] (median)	25 Percent[1]	Number of samples	75 Percent[1]	50 Percent[1] (median)	25 Percent[1]
Sand and gravel								
Glacial outwash	13	98	142	291	10	34	50	58
Sandstone and shale	102	77	111	161	96	34	34	51
Mauch Chunk Formation	2	—	20	—	2	—	17	—
Catskill Formation	68	70	100	156	57	34	34	51
Duncannon Member	1	—	60	—	1	—	17	—
Sherman Creek Member	34	65	102	179	33	34	51	68
Irish Valley Member	33	82	100	149	33	34	34	51
Trimmers Rock Formation	32	103	133	176	27	34	51	51
Devonian shale	94	224	320	400	91	86	120	154
Harrell and Mahantango Formations	68	219	300	377	66	86	120	154
Marcellus Formation	26	299	366	452	25	77	137	162
Carbonate rock and shale	30	218	338	531	26	137	176	263
Onondaga and Old Port Formations	17	207	347	675	14	162	214	330
Wills Creek Formation	13	238	320	465	12	136	154	180
Carbonate rock								
Keyser and Tonoloway Formations	21	360	408	668	20	158	202	280
Silurian shale								
Bloomsburg Formation	10	131	205	405	7	51	86	103
Sandstone, limestone, and shale	29	147	180	225	29	60	86	103
Mifflintown and Keefer Formations	9	147	200	270	9	51	103	103
Rose Hill Formation	20	146	175	219	20	68	77	86
Upper member	7	145	200	230	7	68	68	86
Middle and lower members	13	140	70	210	13	60	86	95

[1]Percentage of samples in which field measurement value was equaled or exceeded.

groundwater. A few wells completed in bedrock zones where groundwater does not actively circulate may tap water of the sodium chloride type. Only two of these "salt wells" (Co-471 and Co-382) were inventoried in the study area, and the problem of saline water in shallow aquifers is not widespread in this area of Pennsylvania. Sodium sulfate water was present in one well (Co-190) in the Marcellus Formation, and calcium sulfate water was present in two wells (Mt-31 and Nu-189) in the Keyser and Tonoloway Formations.

Most groundwater tapped by wells is acceptable for domestic supply and human consumption, although hardness, iron and manganese, and hydrogen sulfide gas in excess of recommended limits cause problems locally. These water-quality problems are generally associated with certain bedrock units. Hardess of groundwater, caused primarily by dissolved calcium and magnesium, causes "scale" encrustation in pipes and boilers, and poor lathering of soap products. Iron and manganese may impart a bitter taste to water and cause staining of plumbing fixtures and laundry. Hydrogen sulfide gas commonly is present in groundwater from dark-shale aquifers, such as the Harrell, Mahantango, or Marcellus Formations.

The gas imparts a disagreeable (rotten egg) odor when it effervesces from tap water. In the following sections, these dissolved constituents and others that affect the quality of groundwater in the Berwick-Bloomsburg-Danville area are discussed.

Dissolved Solids and Specific Conductance

The concentration of dissolved solids typically is used as a criterion of water quality and for comparison of water from different hydrogeologic settings. In groundwater that is not affected significantly by man's activities, the concentration of dissolved solids in groundwater, and the corresponding specific conductance, is governed chiefly by the composition of the rock material through which the water passes and by the length of time the water is in contact with this material. Some of the dissolved solids in groundwater, however, are derived initially from atmospheric precipitation. Wood (1980) estimated that precipitation that has been concentrated by evaporation and transpiration may account for about 35 mg/L of the total dissolved solids reaching the groundwater system. Man's activities, such as application of fertilizers and pesticides, waste disposal in landfill and sewage systems, de-icing of highways using salts, and accidental spills of chemical compounds, may affect the type and increase the amount of dissolved solids in groundwater.

Specific conductance is a measure of the electrical conductivity of an aqueous solution at a given temperature, and results are reported in micromhos per centimeter (μmho/cm) at 25 °C. Because the conductivity of water is directly related to concentrations of certain dissolved constituents in a sample, specific conductance (which is easily measured in the field) commonly is used as a measure of dissolved-solids concentration.

Total dissolved solids, in milligrams per liter, of a sample of groundwater in the Berwick-Bloomsburg-Danville area can be estimated by multiplying the field value of specific conductance in micromhos per centimeter by 0.63. This equivalence factor was developed from data obtained from all aquifers in the area. It agrees with results from other areas in Pennsylvania (Johnson, 1970; Carswell and Lloyd, 1979; Becher and Root, 1981). The relationship between dissolved solids and specific conductance varies from this value for individual geologic units. The differences are due in part to the varying effects on specific conductance of the different dissolved constituents derived from the geologic units.

The highest median dissolved-solids concentrations and specific conductances were observed in groundwater from the Harrell-to-Wills Creek stratigraphic sequence (Tables 18 and 19). Water from the carbonate-rock aquifer, the Keyser and Tonoloway Formations, has the highest median dissolved-solids concentration (374 mg/L) and specific conductance (408 μmho/cm). In general, the dissolved-solids concentration increases as the carbonate content increases in an aquifer. In the calcium bicarbonate groundwater common in most of the Berwick-Bloomsburg-Danville area, calcium and magnesium make up most of the dissolved solids, although sodium, chloride, and sulfate also may contribute.

The maximum recommended limit for total dissolved solids in drinking water is 500 mg/L (U.S. Environmental Protection Agency, 1976a). The equivalent of this level for specific conductance is about 860 μmho/cm. Nine wells (3 percent of total wells) had dissolved-solids concentrations or specific conductances greater than the recommended limit. The high level of dissolved solids in these wells generally is due to excessive sodium chloride, calcium sulfate, or sodium sulfate in bedrock zones where groundwater does not actively circulate.

Hardness

The hardness of water depends chiefly upon the concentrations of calcium and magnesium in solution. As a result, aquifers containing soluble carbonate rock generally show the greatest hardness. Water having excess hardness causes scale incrustation in pipes and boilers, requires more soap for lathering, and readily leaves a curd deposit on bathtubs and wash basins.

Total hardness may be expressed as milligrams per liter of $CaCO_3$. Ranges of hardness are expressed in the following descriptive terms (Hem, 1970):

Soft	0–60 mg/L
Moderately hard	61–120 mg/L
Hard	121–180 mg/L
Very hard	>180 mg/L

Hardness increases as the carbonate content increases in an aquifer, as shown in Figure 19. Groundwater from glacial-outwash and Mississip-

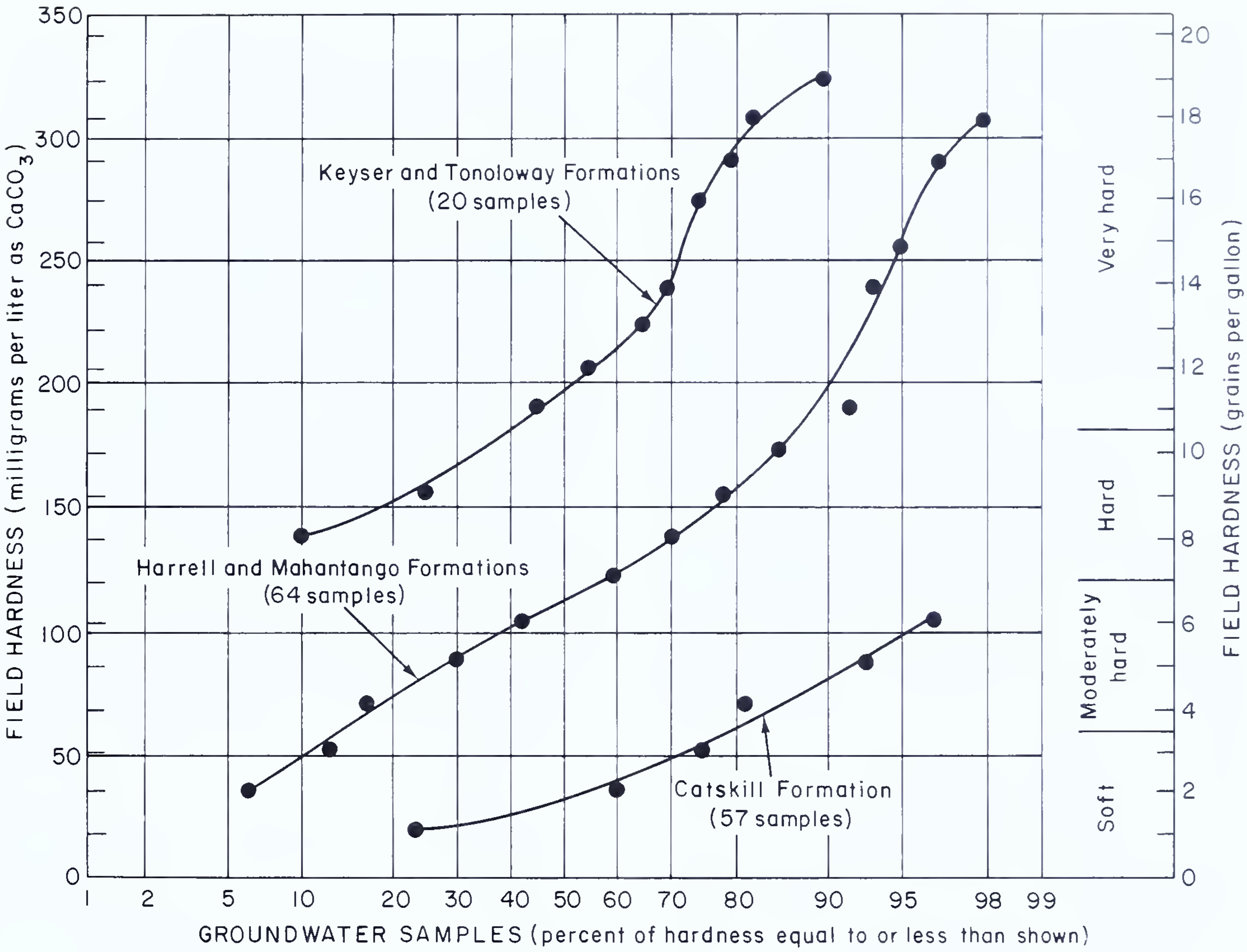


Figure 19. Cumulative percentages of hardness for the Keyser and Tonoloway Formations, Harrell and Mahantango Formations, and Catskill Formation.

pian and Devonian sandstone and shale aquifers, such as the Mauch Chunk, Catskill, and Trimmers Rock Formations, generally is soft, whereas groundwater from aquifers containing shales that are locally calcareous, such as the Harrell, Mahantango, and Bloomsburg Formations, is moderately hard. The carbonate rocks of the Keyser and Tonoloway Formations commonly yield very hard water.

The U.S. Environmental Protection Agency does not specify drinking-water standards for total hardness, but the American Water Works Association (Bean, 1962) suggests that water should not contain more than 80 mg/L of hardness. Fifty-three percent of the field measurements for hardness (Table 23) exceeded the suggested limit. Water conditioners installed in plumbing systems reduce hardness to more acceptable levels by replacing calcium and magnesium ions in solution with sodium ions, but those people who must reduce their dietary intake of sodium should be aware of this.

Iron and Manganese

Iron and manganese commonly are found in low concentrations in groundwater, but these metals may constitute an objectionable impurity even at low concentrations. Recommended limits for iron (300 μg/L [micrograms per liter]) and for manganese (50 μg/L) have been established by the U.S. Environmental Protection Agency (1976a) because an excess of either metal may cause a bitter taste and staining on laundry and plumbing fixtures. Natural sources of iron and manganese are sulfides, oxides, and hydroxides common in most rocks and soils. Slightly acidic, poorly buffered groundwater

may dissolve up to 5,000 μg/L of iron (Hem, 1970). As water pressure is lowered during withdrawal of groundwater from an aquifer and the water is exposed to air, ferrous iron in solution oxidizes and precipitates as reddish-brown ferric iron. This precipitate may stain or even clog pumps, pipes, and plumbing fixtures. Manganese precipitation leaves a black stain and also may clog pumps and plumbing systems. Concentrations of less than 1,000 μg/L iron or 300 μg/L manganese may be effectively treated by filters attached to the plumbing systems.

Concentrations of iron greater than the recommended limit may be found in groundwater from any aquifer in the Berwick-Bloomsburg-Danville area. Dissolved iron exceeded 300 μg/L in 46 percent of water samples. The problem of iron is most noticeable in the Devonian shales of the Harrell, Mahantango, and Marcellus Formations, from which 17 of the 25 samples exceeded the recommended limit. The median concentration of iron was 660 μg/L in the Harrell and Mahantango Formations and 1,100 μg/L in the Marcellus Formation. The highest concentration of iron was observed in the Harrell and Mahantango Formations in well Co-60 (2,900 μg/L). Iron concentrations greater than 1,000 μg/L also were observed in groundwater from glacial outwash, and from the Marcellus, Onondaga, and Old Port Formations.

Excessive concentration of manganese is also a problem in many aquifers. About 40 percent of the water samples exceeded the recommended limit for manganese. Groundwater from glacial outwash had the highest median concentration of manganese (600 μg/L) and the highest individual concentration (8,100 μg/L) in well Co-308. Fourteen of 17 samples from the Marcellus Formation and the middle and lower members of the Rose Hill Formation contained manganese in excess of the recommended limit.

Nitrate

Nitrate typically is the principal form of nitrogen in groundwater, but nitrite or ammonium may be present in reducing environments where dissolved oxygen has been depleted from the groundwater. Sources of nitrate generally are associated with biological material. This includes fecal waste from stock animals and humans, and nitrate produced in soils and leguminous plants by nitrification of atmospheric nitrogen. Fertilizers and decaying mulch also supply nitrate. In general, excess nitrate in soils dissolves with infiltrating water and reaches the groundwater system primarily during recharge events.

The maximum recommended concentration of nitrate in drinking water is 10 mg/L, expressed as nitrogen (U.S. Environmental Protection Agency, 1976a). Nitrate levels higher than this may cause methemoglobinemia in infants, and families using springs, dug wells, or inadequately cased drilled wells near on-lot septic systems or other sources of nitrates should be aware of potential problems with their water.

Median nitrate concentrations for the geologic units are less than 1 mg/L, except for the Bloomsburg, Catskill, Trimmers Rock, Old Port and Onondaga, and Wills Creek Formations. The elevated median concentrations may be traced to agricultural fertilizers and rural septic systems in these areas. Only one well sampled, Co-188, contained nitrate (17 mg/L as N) in excess of the recommended limit, and failure of the on-lot septic system at this site is the suspected cause.

Chloride

Primary sources of chloride in groundwater in the study area are evaporite deposits and connate brines, and contamination by de-icing salts, septic and sewage systems, and solid-waste disposal. The highest median concentrations of dissolved chloride were observed in the groundwater from the Marcellus-to-Wills Creek stratigraphic sequence. The concentrations in these formations probably reflect the lithologic presence of chloride in this stratigraphic sequence, although man-made contamination may affect concentrations in some wells.

The recommended limit for chloride in drinking water is 250 mg/L (U.S. Environmental Protection Agency, 1976b), primarily for reasons of taste. One well (Lu-471) tapped saline water in the Mahantango Formation that contained 1,500 mg/L of chloride. Another well in the Marcellus Formation, Co-382, contained water with 1,300 mg/L of chloride. Both of these wells are deeper than 300 feet, are located in valleys, and tap saline water from shales of low permeability. The saline water from deep zones in the valleys probably represents connate water that has been diluted but not flushed completely in areas of restricted groundwater circulation. Although the potential exists for saline water in deep wells in valleys underlain by shale, the problem does not appear to be widespread in the study area.

Sulfate

Solution of evaporite deposits (for example, gypsum) and oxidation of pyrite (FeS_2) and other sulfides are the most common sources of sulfate in the study area, although industrial and municipal wastes also may introduce sulfate to groundwater. The highest median concentrations of sulfate were observed in groundwater from the Marcellus, Onondaga and Old Port, and Keyser and Tonoloway Formations. Groundwater from four wells contained sulfate concentrations that exceeded the recommended limit of 250 mg/L (U.S. Environmental Protection Agency, 1976a) for drinking water; these wells were Co-307 (Tonoloway and Wills Creek Formations), Mt-31 (Keyser Formation), Nu-189 (Tonoloway Formation), and Co-190 (Marcellus Formation). Man-made contamination is suspected in well Co-190.

The upper part of the Silurian stratigraphic sequence contains evaporite deposits. As exemplified by wells Co-307 and Mt-31, wells drilled in valley-discharge areas that penetrate the Keyser-to-Wills Creek sequence at depth may produce groundwater having relatively high sulfate concentrations. In general, however, the shallow flow system in this gypsum-bearing sequence has been flushed of sulfate by active circulation of groundwater. Well Nu-189, which is only 120 feet deep and produced water having a sulfate concentration of 1,300 mg/L, is an exception to this generalization.

Hydrogen Sulfide

Hydrogen sulfide is a gas formed from decomposition of organic matter and sulfide or sulfate minerals in an acidic reducing environment. The rotten egg odor of hydrogen sulfide is distinctive and can be detected in water containing concentrations less than 0.5 mg/L (Hem, 1970). Hydrogen sulfide concentrations may be reduced to less objectionable levels by aeration or chemical treatment.

Hydrogen sulfide was detected in 58 of 651 wells, or in about 9 percent of the wells. It was observed most commonly in wells in Devonian shale aquifers (Table 20), such as the Harrell, Mahantango, and Marcellus Formations. Williams (1980) noted that about 28 percent of wells in the Devonian shale in the Danville area contained hydrogen sulfide. Hydrogen sulfide was detected in two wells, Co-154 and Co-308, drilled in glacial outwash. In both of these wells, the dissolved gas may come from upward flow of groundwater and gas into the glacial outwash from underlying Devonian shale bedrock.

Table 20. *Occurrence of Hydrogen Sulfide in the Aquifers*

Aquifer	Number of wells containing H_2S	Number of wells inventoried	Percent occurrence
Glacial outwash	2	20	10
Mauch Chunk Formation	0	3	0
Pocono Formation	0	0	—
Catskill Formation	1	122	.8
Trimmers Rock Formation	11	82	13
Harrell and Mahantango Formations	26	157	17
Marcellus Formation	10	48	21
Onondaga and Old Port Formations	5	50	10
Keyser and Tonoloway Formations	1	45	2.2
Wills Creek Formation	1	55	1.8
Bloomsburg Formation	1	26	3.8
Mifflintown and Keefer Formations	0	12	0
Rose Hill Formation	0	31	0
Total	58	651	8.9

Trace Elements

Elements that typically are present in groundwater at concentrations of less than 1.0 mg/L commonly are called trace elements (Hem, 1970). Results of 18 analyses for selected trace elements in the groundwater of Columbia and Luzerne Counties are in Table 22. Many of the wells were selected for analyses because contamination was suspected, and the results may not represent widespread water-quality characteristics of the aquifers. The analyses show that concentrations of analyzed trace elements, except for concentrations in test hole Co-154, are lower than the recommended limits for drinking water set by the U.S. Environmental Protection Agency (1976a, 1976b). The concentration of nickel in test hole Co-154 was 16,000 $\mu g/L$, which may indicate local contamination caused by nearby waste disposal.

Petroleum Products

Spills or leaks of gasoline and other petroleum products can seriously degrade groundwater quality. The solubility of gasoline in water is about 50 mg/L (McKee and others, 1972), but an odor and taste threshold exists at about 0.005 mg/L (Matis, 1971). Petroleum products readily absorb to soil particles, particularly in the unsaturated zone, and slow release of the fuel to infiltrating water may

preclude use of groundwater in an affected area for an extended period of time. The odor of a petroleum product was detected in two isolated wells in the study area, well Co-60 at Millville and well Co-310 at Bloomsburg. The source or cause of contamination was not determined for either well.

SUMMARY DESCRIPTION OF THE AQUIFERS

GLACIAL OUTWASH

Stratified deposits of glacial-outwash sand and gravel are present in the Susquehanna River and Fishing Creek valleys. The thickest, most areally extensive saturated sand and gravel deposits are found along the Susquehanna River upstream from Mifflinville and along Fishing Creek above Orangeville.

The median estimated well yield for the glacial-outwash aquifer is 190 gal/min. About one of every four wells is capable of yielding 410 gal/min or more. Where the outwash aquifer is tapped for high yields, well screens and natural or artificial gravel packs are used. Drilling problems associated with the outwash deposits include the loss of air circulation when using air-rotary equipment, isolated boulders deflecting drilling bits, and flowing sand, silt, and clay filling the well bore.

Water from the glacial-outwash aquifer generally is soft and has very low to moderate concentrations of dissolved solids. The median dissolved-solids concentration is 95 mg/L. Manganese concentrations in excess of the recommended limit are a common problem. Wells that are without screens or are improperly developed may produce water containing suspended sediment.

MAUCH CHUNK FORMATION

The Mauch Chunk Formation consists of interbedded grayish-red shale, siltstone, and sandstone, and is in part calcareous. It crops out only in the northeastern and southeastern corners of the study area, and little information is available on the water-yielding and water-quality characteristics of the aquifer. Reported yields for two domestic wells, 150 and 200 feet deep, that are located in valleys are 10 and 20 gal/min, respectively. Water-quality data from two wells indicate that the aquifer yields soft water having very low concentrations of dissolved solids.

POCONO FORMATION

The Pocono Formation, which consists of white to light-gray quartzitic sandstone and conglomerate and some interbeds of dark-gray shale, forms the crest of Knob, Lee, and Catawissa Mountains. No information is available on the water-yielding and water-quality characteristics of the Pocono Formation, but its upland setting suggests that wells completed in the aquifer would be deep and low yielding. The aquifer probably yields soft water having a low concentration of dissolved solids.

CATSKILL FORMATION

The Catskill Formation consists of interbedded shale, siltstone, and sandstone that form a broad, dissected highland. The formation is divided into the Duncannon, Sherman Creek, and Irish Valley Members.

Only limited information on the water-yielding and water-quality characteristics of the Duncannon Member is available. An 85-foot-deep well reportedly yielded 30 gal/min of soft water having a very low concentration of dissolved solids.

The median estimated well yield for the Sherman Creek Member is 11 gal/min. About one of every four wells drilled in the Sherman Creek Member is capable of yielding 50 gal/min or more. The median depth of domestic wells is 125 feet. About one of every four domestic wells requires 60 feet of casing or more, because thick glacial deposits overlie much of the outcrop area at the base of Knob and Lee Mountains. The aquifer generally yields soft to moderately hard water having a very low to low concentration of dissolved solids. The median dissolved-solids concentration is 98 mg/L.

The median estimated well yield for the Irish Valley Member, based on only two pump-tested wells, is 11 gal/min. The median depth of domestic wells is 130 feet, and about three of every four domestic wells are 165 feet deep or less. The aquifer generally yields soft water that has very low to low concentrations of dissolved solids. The median dissolved-solids concentration is 63 mg/L.

The maximum interference observed between wells in the Catskill Formation occurred during a 48-hour test, in which the pumping of a well at 55

gal/min caused 74 feet of drawdown in a well located 350 feet away.

TRIMMERS ROCK FORMATION

The Trimmers Rock Formation consists of interbedded gray to dark-gray siltstone and shale, with sandstone in the upper part. It has a median estimated well yield of 5 gal/min. The aquifer underlies a wide range of topographic settings, and well yields vary accordingly. About one of every four domestic wells is more than 275 feet deep. The median depth of casing for domestic wells completed in the aquifer is 22 feet. Water from the aquifer generally yields soft water having a low dissolved-solids concentration. The median dissolved-solids concentration is 78 mg/L. Hydrogen sulfide is a common problem in water from the lower part of the aquifer, where dark-gray shale is abundant.

HARRELL AND MAHANTANGO FORMATIONS

The Harrell Formation consists of dark-gray shale. Interbeds of siltstone are present in the upper part. The Mahantango Formation is composed of greenish-gray to dark-gray shale, which is locally calcareous.

The median estimated well yield for the Harrell and Mahantango Formations is 7 gal/min. About one of every four wells completed in the aquifer is capable of yielding 22 gal/min or more. About three of every four domestic wells are 175 feet deep or less and have less than 40 feet of casing.

The aquifer generally yields moderately hard to hard water that has moderate amounts of dissolved solids. The median concentration of dissolved solids is 144 mg/L. Excessive iron and manganese are common water-quality problems. About 17 percent of wells completed in the aquifer yield water containing hydrogen sulfide. One 470-foot-deep domestic well yielded saline water having a chloride concentration of 1,500 mg/L.

The maximum interference between wells observed in the aquifer occurred during a 40-hour test in which the pumping of one well at 60 gal/min caused 14 feet of drawdown in another well located 787 feet away.

MARCELLUS FORMATION

The Marcellus Formation consists of dark-gray fissile shale. The median estimated well yield for the aquifer is 8 gal/min. About one of every four wells completed in the Marcellus Formation is capable of yielding 23 gal/min or more. The median well and casing depths for domestic wells are 87 feet and 30 feet, respectively.

The Marcellus Formation generally yields the poorest quality water of all aquifers in the study area. It contains moderately hard to hard water that has moderate to high concentrations of dissolved solids. The median concentration of dissolved solids is 265 mg/L. High concentrations of iron and manganese are a common water-quality problem. Hydrogen sulfide was found to be a problem in about 21 percent of the wells in the Marcellus Formation. A 320-foot-deep domestic well produced saline water having a chloride concentration of 1,300 mg/L.

ONONDAGA AND OLD PORT FORMATIONS

The Onondaga Formation is composed of interbedded gray to dark-gray calcareous shale and gray argillaceous limestone. The Old Port Formation consists of interbedded dark-gray chert, calcareous shale, and limestone. Friable sandstone is present locally in the upper part of the Old Port Formation.

The median estimated yield of the Onondaga and Old Port Formations is 91 gal/min. About one of every four wells drilled in the aquifer will potentially yield 310 gal/min or more. About three of every four domestic wells are less than 157 feet deep. The median depth of casing for domestic wells is 35 feet, although one well that penetrated friable sandstone at depth required 76 feet of casing to prevent the well from filling with sand.

In one example, individual water-bearing solution zones developed along two calcareous chert beds in the Old Port Formation were penetrated by wells over a distance of 2,000 feet. High-yield wells that tap such common zones will show significant well interference.

The Old Port and Onondaga Formations generally yield hard to very hard water having moderate to very high concentrations of dissolved solids. The median dissolved-solids concentration is 301 mg/L.

Water-quality problems caused by hydrogen sulfide and excessive iron and manganese concentrations occur locally.

KEYSER AND TONOLOWAY FORMATIONS

The Keyser Formation is composed of gray to bluish-gray, thin- to thick-bedded limestone. The limestone is, in part, argillaceous and dolomitic. The Tonoloway Formation consists of laminated, gray to dark-gray limestone; dolostone occurs in the lower part. These two formations are the primary carbonate-rock aquifer in the study area.

The median estimated well yield for the Keyser and Tonoloway Formations is 180 gal/min. About one of every four wells completed in the carbonate-rock aquifer will potentially yield 620 gal/min or more. Deep water levels and significant thicknesses of weathered rock are associated with the aquifer. As a result, about one of every four domestic wells is more than 210 feet deep and requires 100 feet, or more, of casing. Wells that penetrate mud-filled solution zones that are not cased off may produce turbid water.

During a multiple-well pumping test lasting 72 hours in the carbonate-rock aquifer, a well pumped at 200 gal/min caused 20 feet of drawdown in an observation well located 182 feet away. Twenty-six feet of drawdown was observed in the pumping well. In another example of well interference in the aquifer, pumping during the summer months from a high-production well field caused significant drawdown (about 5 feet) in a well located 2,500 feet away.

The Keyser and Tonoloway Formations generally yield hard to very hard water that has moderate to high concentrations of dissolved solids. The median dissolved-solids concentration of 374 mg/L is the highest of all of the aquifers. The highest median sulfate concentration, 78 mg/L, was also observed in water from the carbonate-rock aquifer, and water from three wells exceeded the recommended limit for sulfate. High concentrations of sulfate are most common in water from deep wells drilled in valley discharge areas of the carbonate-rock aquifer.

WILLS CREEK FORMATION

The Wills Creek Formation is composed of interbedded calcareous shale, argillaceous dolostone and limestone, and calcareous siltstone. The formation is gray, yellowish gray, and greenish gray in the upper part and variegated greenish gray, yellowish gray, and grayish red purple in the lower part. The median estimated well yield for the Wills Creek Formation is 99 gal/min. About one of every four wells completed in the aquifer is capable of yielding 130 gal/min or more. Domestic wells have a median depth of 98 feet. About one of every four domestic wells completed in the aquifer requires 71 feet or more of casing because of significant thicknesses of weathered bedrock.

The Wills Creek Formation generally yields hard to very hard water that has moderate to high concentrations of dissolved solids. The median dissolved-solids concentration for the aquifer is 196 mg/L.

BLOOMSBURG FORMATION

The Bloomsburg Formation consists of grayish-red shale containing interbeds of siltstone. The median estimated well yield for the aquifer is 6 gal/min. About one of every four domestic wells is 211 or more feet deep, and about three of every four domestic wells have 30 feet or less of casing.

The Bloomsburg Formation generally yields soft to moderately hard water having moderate to high concentrations of dissolved solids. The median dissolved-solids concentration is 125 mg/L. In general, the water quality of the aquifer is good, and concentrations of dissolved constituents in excess of recommended limits are uncommon.

MIFFLINTOWN, KEEFER, AND ROSE HILL FORMATIONS

The Mifflintown Formation consists mostly of dark-gray calcareous shale and limestone. The Keefer Formation is composed of light-gray quartzitic sandstone and siltstone containing interbeds of greenish-gray shale. The Rose Hill Formation is divided into three members. The upper member consists of mostly gray to greenish-gray, interbedded shale, limestone, and sandstone; the middle member consists of reddish-purple sandstone containing interbeds of greenish-gray to reddish-purple shale in the upper part; and the lower member consists of greenish-gray shale containing interbeds of gray calcareous sandstone and reddish-brown hematitic sandstone.

The median estimated well yield for the Mifflintown, Keefer, and Rose Hill Formations is 10 gal/min. About one of every four wells completed

in the aquifer is capable of yielding 56 gal/min or more. The aquifer underlies a wide range of topographic settings, and well yields vary accordingly. Specific-capacity data suggest that valley wells drilled in the aquifer are about 10 and 20 times more productive than wells drilled on slopes and hilltops, respectively. In general, deep domestic wells are drilled in upland areas because of significant depths to water-bearing zones. About one of every four domestic wells in the aquifer is 223 feet deep or more.

During the 1800's, deep mining of iron ore in the uppermost Rose Hill Formation occurred in areas along the flanks of the ridge between Danville and Bloomsburg. Now abandoned, these deep mines serve as effective drains that dewater overlying rocks in the Mifflintown and Keefer Formations. Deep wells that are cased below the mines may be required in this setting. It is possible that flooded deep mines could provide significant quantities of good-quality water.

In the Mifflintown, Keefer, and Rose Hill Formations the median depth of casing in domestic wells is 40 feet. However, four domestic wells that penetrated iron ore mines at depth required 70 to 121 feet of casing.

During a multiple-well test lasting 4 hours in the Rose Hill Formation, allowing a well to flow at 75 gal/min caused 40 feet of drawdown in a well located 460 feet away. Interference between wells also was reported during the pumping of a municipal well field. Significant drawdown occurred in domestic wells up to 700 feet away.

The Mifflintown, Keefer, and Rose Hill Formations generally yield moderately hard water having low to moderate concentrations of dissolved solids. Median dissolved-solids concentrations are as follows: Mifflintown and Keefer Formations, 135 mg/L; upper member of the Rose Hill Formation, 90 mg/L; and middle and lower members of the Rose Hill Formation, 100 mg/L. Iron and manganese concentrations that exceed recommended limits are common problems in the middle and lower members of the Rose Hill Formation.

TUSCARORA FORMATION

The Tuscarora Formation consists of interbedded light-gray quartzitic sandstone and grayish-green shale. No information is available on the groundwater resources of the Tuscarora Formation, but its upland setting suggests that wells completed in the aquifer will be deep and low yielding. The aquifer probably yields soft water having a low dissolved-solids concentration.

SUMMARY AND CONCLUSIONS

The Berwick-Bloomsburg-Danville area annually receives an average of 40 inches of precipitation, about one fourth of which recharges the groundwater system. Groundwater is contained in unconsolidated glacial deposits and the underlying bedrock, and it flows from areas of greater altitude to points of discharge (springs and streams) under the gravitational influence of hydraulic-head gradients. In 1980, about 4.7 Mgal/d of water was obtained from wells and springs by the major groundwater users in the study area.

The most important unconsolidated-rock aquifer is the glacial-outwash deposits found along the Susquehanna River and Fishing Creek. The sand and gravel deposits of the glacial-outwash aquifer are highly permeable and have significant storage capabilities. Locally, up to 50 to 70 feet of saturated outwash is present in the Susquehanna River and Fishing Creek valleys.

The bedrock aquifers are gradational sequences of sandstone, shale, and carbonate rock. Groundwater in the bedrock aquifers moves along secondary permeability features, such as fractures and bedding-plane separations. The size of secondary openings in carbonate rocks can be greatly enlarged by removal of calcareous material. The most significant amount of carbonate rock is found in the Wills Creek-to-Onondaga stratigraphic sequence. Within this sequence, the carbonate rock of the Keyser and Tonoloway Formations forms the most favorable bedrock aquifer for obtaining high-yield wells.

The yield of a well depends largely on the size and number of water-bearing zones that it penetrates. The size and number of water-bearing zones decreases with increasing depth, although high yields may occur from deep water-bearing zones in aquifers containing carbonate beds.

Lithology is a major factor controlling well yields. Carbonate-rock and interbedded carbonate-rock and shale aquifers have median specific capacities more than 10 times greater than shale and interbedded sandstone and shale aquifers. Wells completed in sand and gravel of the glacial-outwash aquifer may have the highest specific capacities.

Topography is another significant factor that affects well yields. The median specific capacities for wells in valleys is from 3 to 24 times greater than the medians for wells on hilltops. Wells on slopes

have specific capacities between those for wells in valley and hilltop settings.

The specific capacity of a well decreases with increasing pumping rate and duration of pumping. Doubling of the pumping rate in selected wells caused a 24 to 67 percent reduction in specific capacity. The median reduction for wells in which the pumping water level fell below a water-bearing zone or zones was 59 percent. The median reduction for wells in which aquifer and well losses were the only factors was 38 percent. The reduction of specific capacity after 24 hours of continuous pumping as compared to 1-hour values in selected wells ranged from 17 to 90 percent, and the median decrease was 38 percent. On the average, about two thirds of the decrease in specific capacities occurred after 8 hours of pumping.

The bedrock aquifers have a strong directional permeability along bedding strike. During multiple-well pumping tests in the bedrock aquifers, significant interference was observed only between wells that tapped at least part of the same stratigraphic interval. Interference between wells that are competing for the same water increases the drawdown in each well and will reduce the available specific capacity of each well. The degree of interference is largely dependent on the hydraulic connection between the water-bearing zones that the wells mutually tap.

The groundwater in the Berwick-Bloomsburg-Danville area is chiefly of the calcium bicarbonate type, and most water tapped by wells is acceptable for domestic supply and human consumption. Concentrations of hardness, iron, and manganese that exceed recommended limits, however, may cause some problems in certain aquifers. Hardness in water, caused principally by dissolved calcium and magnesium, is chiefly a problem in aquifers containing carbonate rock. Accordingly, the carbonate rocks of the Keyser and Tonoloway Formations generally yield very hard water, whereas water from shales that are locally calcareous, such as in the Mahantango and Marcellus Formations, is moderately hard. Groundwater from the glacial-outwash aquifer and the sandstone and shale aquifers, such as the Catskill and Trimmers Rock Formations, generally is soft.

Iron and manganese concentrations that exceed recommended limits can be found in groundwater from any aquifer in the study area, although problems are most noticeable in the Devonian shales of the Harrell, Mahantango, and Marcellus Formations. Excessive dissolved manganese commonly was observed in groundwater from glacial outwash, the Marcellus Formation, and the middle and lower members of the Rose Hill Formation. Excessive iron and manganese are problems to the extent that the metals impart a bitter taste to water, stain fixtures and laundry, and clog plumbing systems, but water conditioning will alleviate the most serious problems.

Hydrogen sulfide gas, which imparts a rotten egg odor to groundwater, was detected in 58 of 651 wells, or in about 9 percent of the total. It was present most commonly in wells in the Devonian shale aquifers, such as the Harrell, Mahantango, and Marcellus Formations.

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM UNITS (SI)

Multiply inch-pound units	*By*	*To obtain SI units*
inch	2.540	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
million gallons per day (Mgal/d)	3,785	kiloliter per day (kL/d)
gallon per minute per foot [(gal/min)/ft]	0.2069	liter per second per meter [(L/s)/m]
gallon per minute per square mile [(gal/min)/mi^2]	0.2436	liter per second per square kilometer [(L/s)/km^2]
micromhos (μmho)	1.0	microsiemens (μS)

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows: °F = 1.8 °C + 32

Milligrams per liter (mg/L) is an expression of concentration that is equivalent to parts per million (ppm) and is equal to 1,000 micrograms per liter (μg/L). Micrograms per liter is equivalent to parts per billion (ppb).

TABLE 21. CHEMICAL ANALYSES OF WATER FROM SELECTED WELLS

(Quantities are in milligrams per liter except where otherwise indicated)

Well number	Oate of sample	Silica (SiO_2)	Iron (Fe) (μg/L)	Manganese (Mn) (μg/L)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrogen (NO_2+NO_3, as N)	Orthophosphorus (P)	Dissolved solids	Hardness ($CaCO_3$)	Noncarbonate hardness ($CaCO_3$)	Alkalinity ($CaCO_3$)	pH (units)	Specific conductance (μmho/cm at 25°C)
									GLACIAL OUTWASH										
Co- 80	8/10/71	--	100	70	--	--	--	--	31	10	0.1	0.41	--	144	110	34	76	6.9	--
111	3/ 3/82	7.8	230	21	9.4	3.7	2.8	1.1	16	4.7	<.1	3.5	<0.010	66	39	31	8	6.2	109
154	12/ 8/81	10	10	2,100	80	20	11	3.5	33	13	.2	.04	.050	331	280	22	260	7.9	608
305	10/20/80	12	250	350	11	3.5	3.9	.8	22	5.0	.1	2.8	.000	80	42	27	15	6.1	123
308	8/ 3/81	17	14,000	8,100	110	22	15	1.3	32	12	<.1	.04	.010	472	370	0	400	6.7	804
379	6/ 3/81	9.9	60	10	7.1	3.1	3.2	1.3	14	3.6	.0	3.2	.040	59	31	26	5	5.7	93
Lu-452	7/ 2/81	19	8,200	3,000	17	3.9	7.5	.8	35	17	<.1	.01	<.010	125	59	36	23	6.4	180
455	11/ 6/80	15	1,600	600	7.2	1.4	2.6	1.3	11	2.5	.0	.01	.100	55	24	5	19	6.4	73
486	1/25/73	11	3,550	--	14	5.0	12	--	46	10	--	.20	--	--	56	--	17	6.0	180
490	12/ 6/73	15	280	--	14	3.4	7.3	--	35	3.0	--	.16	--	95	49	--	24	6.5	142
491	11/13/73	11	40	--	12	3.9	6.1	--	37	1.8	--	4.6	--	--	46	--	15	6.2	136
									MAUCH CHUNK FORMATION										
Lu-422	6/24/81	5.7	10	<1	1.6	.7	.4	.2	.7	.6	<.1	.28	<.010	15	7	0	7	6.0	18
									CATSKILL FORMATION										
									Sherman Creek Member										
Co- 49	2/ 8/68	--	150	0	--	--	--	--	51	4.0	.0	3.7	--	108	60	40	20	6.0	--
61	8/12/80	12	370	70	14	3.6	6.3	.9	29	9.6	.1	1.9	.000	95	50	33	17	--	155
66	1/ 8/68	--	200	--	--	--	--	--	--	8.0	.0	1.4	--	110	46	0	75	7.8	--
84	6/23/76	--	<10	<10	--	--	--	--	12	6.5	<.1	4.8	.020	90	60	34	26	6.5	--
85	6/23/76	--	550	<10	--	--	--	--	51	16	<.1	5.4	.020	162	83	37	46	6.8	--
245	8/18/81	13	920	380	33	6.4	27	1.2	35	50	<.1	4.5	<.010	230	110	37	72	6.9	388
372	4/14/81	<.1	30	<1	12	6.8	12	2.2	17	5.3	.1	.47	.090	2	58	0	59	7.0	183
411	6/10/81	11	10	1	15	3.1	4.2	.5	14	2.4	<.1	1.7	.040	78	50	16	34	7.9	123
436	8/27/81	11	40	20	26	7.2	10	.9	11	34	<.1	2.5	.070	134	95	57	38	7.8	222
501	8/19/81	7.2	620	10	3.5	2.6	3.2	.8	.8	6.4	<.1	4.7	<.010	50	19	12	7	5.8	75
503	8/27/81	11	30	<10	4.0	1.5	2.6	.5	.3	1.9	<.1	1.6	.020	37	16	3	13	7.0	46
504	11/ 5/81	9.9	520	26	4.2	1.9	4.0	.2	2.3	7.4	.0	2.4	.010	46	18	10	8	5.8	63
522	9/22/81	12	50	1,200	15	4.0	8.1	.6	2.5	9.7	<.1	4.7	.030	100	54	10	44	6.9	164
565	11/ 5/81	8.6	2,000	29	1.9	1.1	1.1	.4	1.0	1.1	.0	.03	.010	26	9	0	14	6.1	21
584	2/18/82	17	47	8	22	7.3	10	.5	2.0	23	<.1	7.7	.060	143	85	40	45	6.7	228
Lu-512	9/29/81	17	220	340	30	3.0	5.3	.3	1.6	.6	.1	.02	<.010	125	87	0	110	7.8	206
									Irish Valley Member										
Co-244	2/23/82	9.8	260	13	2.8	3.2	2.7	.6	1.4	2.7	<.1	3.7	<.010	43	20	14	6	5.9	58
377	6/ 3/81	16	210	90	2.0	2.8	3.2	.5	.5	.3	.1	.14	.050	36	17	1	16	6.1	49
421	6/25/81	10	260	40	2.9	4.3	6.7	.8	.2	14	<.1	1.5	<.010	53	25	13	12	5.2	100
562	10/ 8/81	18	260	150	17	6.5	8.6	.7	1.0	5.7	.3	.11	<.010	101	69	0	71	7.6	170
567	11/ 9/81	16	36	130	12	5.4	14	.6	11	4.4	.1	.09	<.010	100	52	0	60	7.8	148
585	2/23/82	20	2,500	480	3.4	4.7	5.4	.4	4.2	1.4	.2	.02	.020	63	28	0	33	6.9	79
Nu-162	8/ 6/80	14	1,600	40	12	4.8	4.4	.7	28	7.7	.1	2.6	.000	93	50	37	13	--	150

TRIMMERS ROCK FORMATION																			
Co-215	4/ 8/82	11	9	8	3.8	2.2	2.6	0.1	5.0	2.9	<.1	3.6	<0.010	49	19	10	9	6.0	67
354	2/23/82	12	1,700	220	11	3.4	3.9	.3	6.9	3.8	<.1	1.4	<.010	68	41	10	31	6.6	100
364	4/ 2/82	9.7	42	9	5.8	5.4	3.7	1.2	8.3	6.6	<.1	6.0	<.010	73	37	27	10	6.1	112
365	2/18/82	20	190	85	5.2	7.0	9.6	.5	5.6	2.6	.2	.28	.020	82	42	0	50	7.4	119
368	8/ 3/81	13	120	20	9.8	6.9	4.9	1.0	24	5.6	<.1	4.9	<.010	96	53	38	15	6.6	153
Mt-160	2/23/82	10	74	34	5.9	3.3	3.6	.3	8.1	1.6	<.1	1.9	<.010	51	28	12	16	7.0	74
186	11/12/81	13	26	65	18	4.7	5.8	.7	15	4.0	.2	.90	<.010	97	64	12	52	7.9	149
237	3/ 3/82	19	52	35	23	8.5	13	.5	14	4.2	.1	.02	.050	143	92	0	100	8.0	233
HARRELL FORMATION																			
Co-336	8/20/81	15	1,700	90	3.0	2.5	3.0	.3	9.7	.9	<.1	.06	<.010	44	18	5	13	6.9	55
Lu-371	8/26/81	86	900	40	8.0	2.3	3.3	1.4	14	4.6	<.1	1.1	<.010	54	29	19	10	6.6	86
MAHANTANGO FORMATION																			
Co- 56	12/18/73	8.5	860	40	26	3.5	107	27	15	172	.2	.28	.100	429	80	0	11	8.0	820
60	5/14/81	12	29,000	590	35	11	29	2.2	31	83	<.1	.02	<.010	267	130	77	56	6.1	492
126	8/20/81	6.7	2,200	40	4.1	2.5	3.0	.6	.4	5.7	<.1	4.1	<.010	48	21	13	8	6.1	72
212	6/ 3/81	17	1,800	50	35	9.9	18	.6	18	15	.2	<.01	.050	194	130	0	130	7.8	324
320	6/24/81	24	7,900	3,000	53	12	11	.8	22	86	<.1	2.5	<.010	261	180	130	51	7.1	464
333	8/13/81	19	20	30	18	3.2	5.7	.3	5.2	2.0	.1	.49	.030	91	58	0	59	7.3	136
335	8/13/81	14	20	20	13	3.4	3.8	.4	16	5.5	<.1	1.1	.010	77	46	19	27	6.6	124
454	7/22/81	14	410	10	4.9	1.7	1.3	1.0	13	2.0	<.1	1.9	<.010	48	19	17	2	4.8	71
468	8/12/81	16	100	20	32	7.4	16	1.9	22	12	.2	.06	.040	174	110	0	110	8.4	284
Lu-372	8/13/81	17	50	80	31	6.9	9.1	.2	21	1.3	.2	.07	.020	153	110	0	110	7.4	248
434	7/30/81	16	120	140	32	6.4	12	.3	27	6.3	.2	.60	<.010	161	110	9	97	7.7	248
453	11/18/81	13	16	28	19	3.4	30	.4	14	3.6	.2	.06	<.010	144	61	0	100	8.0	234
456	8/26/81	11	30	10	23	3.7	5.3	.6	16	4.1	.1	.15	<.010	99	73	16	57	7.4	162
471	1/22/81	8.1	3,500	200	70	20	1,000	3.1	2.8	1,500	.6	.02	.010	2,670	260	150	--	8.0	4,720
Mt-153	8/ 6/80	20	580	430	33	7.5	8.2	.6	20	1.6	.2	.07	.050	165	110	0	120	--	280
178	8/18/81	21	120	60	27	6.7	9.4	.5	23	1.4	.1	.01	.070	145	95	2	93	8.0	220
Nu-157	11/ 4/81	19	740	130	9.4	3.8	4.7	.3	9.4	.7	.1	<.01	.040	72	39	0	39	7.0	98
MARCELLUS FORMATION																			
Co-187	4/14/81	9.5	180	<1	60	13	9.6	1.0	46	28	<.1	3.0	<.010	265	200	63	140	7.4	480
190	8/26/81	11	1,100	270	32	8.6	500	2.4	760	23	.1	.02	<.010	1,600	120	0	430	7.8	2,180
306	6/23/81	15	320	200	55	9.6	4.5	.4	47	14	<.1	.01	<.010	212	180	67	110	7.8	364
452	7/15/81	18	530	70	37	10	14	.4	38	2.0	.1	<.01	.020	198	130	4	130	6.6	314
Lu-438	8/ 5/80	16	3,000	160	41	7.2	7.3	.8	26	3.2	.2	.13	.000	178	130	12	120	--	300
Mt- 30	9/13/73	--	7,000	--	78	26	--	--	20	155	--	.00	--	840	300	--	100	--	--
175	4/13/81	20	14,000	1,500	40	15	30	1.6	61	35	.2	.03	<.010	297	160	32	130	6.9	489
ONONDAGA FORMATION																			
Co-188	9/23/81	7.3	60	<10	100	23	28	2.7	76	59	<0.1	17	0.000	492	340	140	200	7.7	782
441	8/ 4/81	7.3	400	20	72	15	15	2.1	40	38	<.1	3.2	<.010	306	240	72	170	7.0	571
Mt- 17	9/17/73	--	3,350	0	38	8.0	--	--	46	2.0	--	.02	--	268	126	--	100	--	--
OLD PORT FORMATION																			
Co- 58	4/ 1/68	--	100	--	--	--	--	--	--	20	.0	5.0	--	296	170	54	116	7.2	--
59	4/ 1/68	--	0	--	--	--	--	--	--	20	.0	7.0	--	274	140	26	114	7.4	--
183	8/13/81	7.7	620	10	35	6.2	5.4	.7	34	11	<.1	4.3	.020	156	110	53	60	6.5	264
Mt- 16	9/ 4/73	--	11,000	0	48	20	--	--	210	7.0	--	.10	--	832	200	--	120	--	--
32	1/29/74	--	1,100	0	65	20	--	--	50	72	--	.03	--	438	240	--	128	--	--
KEYSER FORMATION																			
Co- 57	4/ 1/68	--	0	--	--	--	--	--	78	132	.0	4.8	--	434	120	0	125	7.3	--
310	8/ 4/81	2.3	2,000	430	94	18	18	1.3	62	66	<.1	.01	<.010	372	310	130	180	6.8	686
Mt- 2	5/24/71	6.6	40	10	65	11	8.7	--	20	20	.1	4.0	.010	250	210	43	167	7.7	416
14	4/16/74	--	1,100	0	33	25	--	--	61	20	--	1.4	--	374	180	--	184	--	--

TABLE 21. (CONTINUED)

Well number	Date of sample	Silica (SiO_2)	Iron (Fe) (µg/L)	Manganese (Mn) (µg/L)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrogen (NO_2+NO_3, as N)	Orthophosphorus (P)	Dissolved solids	Hardness ($CaCO_3$)	Noncarbonate hardness ($CaCO_3$)	Alkalinity ($CaCO_3$)	pH (units)	Specific conductance (µmho/cm at 25°C)
KEYSER FORMATION (CONTINUED)																			
Mt -31	12/29/72	--	300	0	152	28	--	--	625	76	--	.00	--	1,040	550	--	140	--	--
Nu-187	12/ 3/81	11	9	3	75	13	22	1.7	84	38	.1	6.4	.090	345	240	120	120	7.8	557
188	11/24/81	11	13	3	107	24	34	2.0	190	46	.2	4.4	<.010	518	370	230	140	7.7	796
189	11/24/81	20	390	10	350	120	10	.9	1,300	13	1.4	.12	<.010	1,890	1,400	1,200	130	7.6	2,070
TONOLOWAY FORMATION																			
Co-304	10/20/80	12	10	10	38	8.7	4.9	.6	28	6.3	.1	1.7	.010	163	130	37	94	7.7	282
307	7/ 1/81	16	460	80	110	33	7.5	1.0	270	6.6	.3	.86	<.010	521	410	290	120	7.5	736
410	6/ 3/81	8.4	110	20	64	18	13	1.7	48	31	.1	.83	.060	278	230	84	150	7.4	505
505	10/13/81	9.2	4	2	34	19	2.3	.5	23	2.9	.1	.05	.010	175	160	23	140	8.2	294
Mt- 15	4/23/74	--	370	0	64	20	--	--	110	7.0	--	.00	--	382	258	--	160	--	--
WILLS CREEK FORMATION																			
Co- 70	7/ 7/81	12	1,900	50	63	25	17	.9	140	29	.2	.46	<.010	375	260	120	140	7.7	644
86	5/13/73	--	20	50	--	--	--	--	15	18	<.1	.11	--	220	110	5	105	5.0	--
87	5/13/73	--	20	50	--	--	--	--	12	19	<.1	.13	--	219	110	0	110	5.0	--
106	8/13/81	11	10	<1	37	8.7	4.6	.7	26	10	<.1	4.8	<.010	166	130	51	77	7.9	276
159	8/ 4/81	9.3	30	10	53	23	7.0	.8	82	18	<.1	8.4	<.010	296	230	120	110	7.8	509
201	8/ 5/80	9.6	420	2	39	20	6.0	.6	32	12	.1	3.0	.000	217	180	40	140	--	400
204	10/23/80	--	10	3	--	--	--	--	23	71	--	2.8	--	--	150	--	140	7.5	--
205	10/29/80	--	10	2	--	--	--	--	32	35	--	1.6	--	--	80	--	120	8.2	--
404	6/25/81	7.0	20	<1	45	7.6	2.4	.5	2.3	29	<.1	6.3	<.010	174	140	57	87	7.3	316
413	6/23/81	7.6	230	60	37	10	8.0	.7	14	15	<.1	2.5	<.010	163	130	36	98	7.6	392
453	7/22/81	7.1	170	6	25	15	1.2	.6	8.6	7.4	<.1	7.5	.020	143	120	49	75	8.1	244
457	7/30/81	7.2	70	10	38	7.5	3.9	.6	2.4	10	<.1	7.7	<.010	160	130	33	93	7.1	262
BLOOMSBURG FORMATION																			
Co- 45	4/ 9/81	12	280	130	43	11	9.3	1.1	30	56	0.1	5.0	0.710	213	150	110	46	7.7	387
88	5/13/73	--	250	30	--	--	--	--	20	2.5	<.1	.10	--	130	64	0	67	5.0	--
357	7/21/81	14	760	8	9.1	3.0	3.0	.6	7.3	1.0	<.1	2.2	.110	60	35	16	19	6.7	89
371	7/21/81	20	1,100	180	12	3.4	2.7	.7	16	1.0	.2	.01	.130	76	44	13	31	7.7	102
437	7/ 1/81	8.8	980	30	15	3.4	1.7	.3	2.0	5.2	<.1	2.9	<.010	70	51	20	31	6.8	112
455	7/21/81	9.2	60	2	32	6.7	4.6	.6	7.7	1.0	<.1	4.3	.070	128	110	29	79	6.9	234
460	7/29/81	8.1	6,200	50	21	6.9	3.4	1.5	20	8.5	<.1	2.5	<.010	113	81	38	43	6.2	188
461	7/28/81	10	8,000	5,300	97	18	37	6.0	36	100	<.1	.74	.020	459	320	86	230	6.5	864
462	7/29/81	8.1	70	2	24	4.2	9.6	5.4	32	11	<.1	8.9	.220	148	77	54	23	6.5	226
463	7/29/81	8.7	30	1	28	6.9	3.7	.5	19	6.7	<.1	1.5	<.010	125	98	23	75	7.8	208
569	12/ 8/81	16	8	7	18	3.6	3.7	.7	20	1.5	.1	1.5	.110	93	60	22	38	7.2	152
MIFFLINTOWN AND KEEFER FORMATIONS																			
Co-128	2/17/82	8.3	7	3	46	6.8	2.9	.4	30	9.0	<.1	.58	<.010	166	140	43	100	7.9	287
157	2/23/82	7.2	100	13	18	3.3	3.2	.4	7	12	<.1	2.9	.020	83	59	28	31	6.5	135
331	2/17/82	14	11	1,500	38	4.7	11	.8	24	12	.2	3.6	.020	179	110	19	95	7.4	300
332	2/17/82	7.9	37	38	20	4.6	25	.2	19	8.5	.2	.11	.010	136	69	0	84	7.9	225
355	2/18/82	6.2	410	27	11	4.4	8.4	.8	.7	32	<.1	4.8	<.010	88	46	42	4	6.1	164
570	12/17/81	8.1	8	100	22	5.8	2.1	.5	16	3.5	.1	.04	<.010	97	79	14	65	8.0	171
586	3/ 3/82	10	200	65	30	8.7	5.4	.7	5.5	2.4	.1	.02	<.010	135	110	0	120	7.8	229

ROSE HILL FORMATION																				
Upper Member																				
Mt-181	10/ 6/81	8.4	140	76	24	12	2.7	.6	12	4.1	.2	.04	<.010	117	110	21	88	7.9	216
185	11/12/81	11	54	140	23	11	4.0	.3	32	1.6	.1	.03	<.010	128	100	28	75	7.9	208
221	2/23/82	9.5	54	140	23	11	66	<.1	21	20	.2	.01	<.010	46	--	--	81	8.0	262
227	4/ 8/82	9.7	9	7	20	4.2	4.6	<.1	8.9	1.0	.2	<.10	<.010	90	67	0	69	7.7	146
235	2/23/82	7.6	28	3	21	3.3	2.4	.4	2.2	9.8	<.1	1.6	<.010	84	66	15	51	6.7	156
Middle and Lower Members																				
Mt- 29	7/14/80	7.2	400	90	24	13	.6	1.2	6.5	.6	.2	--	--	126	110	0	120	7.6	240
36	9/22/81	10	--	--	--	--	--	--	14	4.0	.2	.40	.010	--	--	--	110	7.6	246
123	8/18/81	7.5	360	160	28	13	.9	1.0	4.7	1.9	.2	.01	.010	118	120	23	100	7.7	200
176	8/17/81	7.3	1,500	340	17	14	.6	.6	3.3	1.4	.2	.01	.010	102	100	7	93	7.1	178
214	9/22/81	6.1	700	120	11	6.3	.6	.4	2.6	.8	.1	.30	.000	57	53	8	45	7.3	96
245	9/17/81	6.0	30	10	17	8.8	3.2	.9	14	1.6	.2	.02	.140	93	79	11	68	7.4	164
247	9/22/81	6.3	10	<10	63	12	2.5	.6	37	8.6	<.1	4.2	.020	233	210	67	140	7.8	374
248	9/22/81	6.2	90	130	14	10	3.9	.6	11	1.8	.2	.20	.000	93	76	2	74	7.4	164
249	9/23/81	6.1	80	200	21	9.4	1.4	.8	3.2	1.4	.2	.03	.000	100	91	0	93	8.0	184
250	9/23/81	6.7	30	330	7	9.7	7.0	.8	11	7.2	.2	5.7	.060	100	57	16	41	7.2	162
251	9/30/81	7.5	1,300	510	1.9	8.4	.4	.6	.3	.8	.1	.05	<.010	44	39	3	36	6.6	78
255	4/28/82	7.4	940	440	22	16	1.3	1.5	6.0	1.1	.2	<.10	<.010	129	120	1	120	7.5	237

TABLE 22. TRACE-ELEMENT AND ORGANIC-INDICATOR ANALYSES OF WATER FROM SELECTED WELLS

			Dissolved trace metals (μg/L)												Organic indicator (mg/L)			
Well number	Geo-logic unit[2]	Date of sample	Arsenic (As)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Hexavalent chromium (Cr^{+6})	Copper (Cu)	Cyanide (CN)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Selenium (Se)	Zinc (Zn)	Oil and grease	Dissolved organic carbon	Suspended organic carbon	Phenol (μg/L)
Co-154	Qgo	12- 8-81	1	<1	1	<10	<1	42	<10	3	<0.1	1,600	<1	400	<1	7.2	3.3	3
190	Dmr	8-26-81	5	<10	2	10	<1	3	<10	5	.2	5	<1	10	1	3.7	>5.0	<1
308	Qgo	8- 3-81	20	0	1	10	<1	2	<10	1	<.1	5	<1	10	2	1.0	---	---
310	DSk	8- 4-81	12	1	1	10	<1	1	<10	1	<.1	4	<1	4	1	2.0	---	0
357	Sb	7-21-81	2	<1	1	<10	0	35	<10	3	<.1	1	0	7	0	8.5	---	0
371	Sb	7-21-81	10	<1	<1	<10	0	13	<10	3	<.1	1	0	10	1	.4	---	0
436	Dcs	8-27-81	1	<10	2	<10	<1	8	<10	3	.2	4	<1	10	1	6.0	.2	<1
453	Swc	7-22-81	1	<1	<1	10	0	24	<10	12	<.1	1	0	<4	0	.6	---	0
454	Dmh	7-22-81	1	<1	<1	<10	0	98	<10	19	<.1	18	1	60	1	<.3	---	0
455	Sb	7-21-81	2	<1	3	<10	0	13	<10	3	.1	2	0	20	1	.3	---	0
457	Swc	7-30-81	3	1	1	10	<1	3	<10	1	<.1	2	1	9	1	3.4	.2	8
460	Sb	7-29-81	1	<1	2	<10	<1	14	---	32	<.1	4	0	90	---	---	---	---
461	Sb	7-28-81	22	<1	1	<10	<1	11	<10	12	.1	15	0	160	0	15	3.4	0
462	Sb	7-29-81	2	1	1	10	<1	53	<10	1	<.1	4	<1	100	0	4.0	.3	2
463	Sb	7-29-81	4	1	1	10	<1	8	<10	1	<.1	4	<1	20	0	10	---	4
569	Sb	12- 8-81	2	<1	<1	<10	<1	24	<10	1	<.1	5	<1	15	<1	5.6	.1	<1
570	Sm	12-17-81	1	<1	2	10	<1	<1	<10	<1	.1	<1	<1	5	<1	.3	.2	5
Lu-434	Dmh	7-30-81	1	1	1	10	<1	5	<10	1	<.1	2	<1	4	0	4.2	---	6
Recommended limit[3]			50	---	10	50	50	[4]1,000	200	50	2	---	10	[4]5,000	---	---	---	[4]1

[1]Analyzing agency: U.S. Geological Survey, Central Laboratory, Atlanta, Georgia.

[2]Geologic unit: Qgo, Glacial outwash; Dcsc, Sherman Creek Member of Catskill Formation; Dmh, Mahantango Formation; Dmr, Marcellus Formation; DSk, Keyser Formation; Swc, Wills Creek Formation; Sb, Bloomsburg Formation; Smk, Mifflintown and Keefer Formations.

[3]U.S. Environmental Protection Agency (1976a, 1976b).

[4]The given level is for controlling undesirable taste and odor quality.

TABLE 23. RECORD OF SELECTED WELLS AND TEST HOLES

Well location: The number is that assigned to identify the well or test hole. It is prefixed by a two-letter abbreviation of the county. The lat-long is the coordinates, in degree and minutes, of the southeast corner of a 1-minute quadrangle within which the well is located.

Use: A, air conditioning; C, commercial; H, domestic and small commercial; I, irrigation; N, industrial; O, observation; P, public supply; R, recreation; S, stock; T, institution; U, test hole.

Topographic setting: C, stream channel; H, hilltop; S, hillside; T, terrace; V, valley flat; W, upland draw.

Aquifer: Qal, alluvium; Qgo, glacial outwash; Qt, till; Mmc, Mauch Chunk Formation; Dcd, Duncannon Member of Catskill Formation; Dcsc, Sherman Creek Member of Catskill Formation; Dciv, Irish Valley Member of Catskill Formation; Dtr, Trimmers Rock Formation; Dh, Harrell Formation; Dmh, Mahantango Formation; Dmr, Marcellus Formation; Don, Dnondaga Formation; Do, Dld Port Formation; DSk, Keyser Formation; Sto, Tonoloway Formation; Swc, Wills Creek Formation; Sb, Bloomsburg Formation; Smk, Mifflintown and Keefer Formations; Sru, upper member of Rose Hill Formation; Srm, middle member of Rose Hill Formation; Srl, lower member of Rose Hill Formation.

Lithology: dls, dolostone, limestone, and shale; ls, limestone; lsd, limestone and dolostone; lss, limestone and shale; sd, sand; sg, sand and gravel; sh, shale; sls, sandstone, limestone, and shale; slt, silt; sssh, sandstone and shale.

Static water level: Depth--F, flows but head is not known; minus sign indicates that water level is above land surface.

Date--month/last two digits of year.

Reported yield: gal/min, gallons per minute.

Specific capacity: (gal/min)/ft, gallons per minute per foot of drawdown.

Pumping rate: gal/min, gallons per minute. Where no pumping rate is indicated, specific capacities were determined from drillstem and bailer test data reported by drillers.

Hardness: mg/L, milligrams per liter.

Specific conductance: μmho/cm at 25°C, micromhos per centimeter at 25 degrees Celsius.

TABLE 23.

Well location								
Number	Lat-Long	Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
								COLUMBIA
Co- 1	4100-7627	Howers	---	---	H	490	T	Qgo/sg
45	4100-7626	U.S. Geological Survey	Ralph Meyers	1970	O	690	H	Sb/sh
47	4107-7632	Millville Water Authority	---	---	P	630	V	Qal/sg
48	4059-7627	Magee Carpet Co.	---	---	N	475	T	Do/lss
49	4057-7627	Catawissa Water Authority	---	---	P	480	V	Dcsc/sssh
51	4059-7627	Bloomsburg Mills, Inc.	Kohl Brothers	1940	A	490	T	Do/lss
52	4059-7627	do.	do.	1944	A	490	T	Do/lss
53	4059-7627	do.	do.	1964	A	490	T	Do/lss
56	4107-7632	Millville Water Authority	Norman Hagenbuch	1953	P	630	V	Dmh/sh
57	4103-7613	Keystone Water Co.	Cresswell	1957	P	500	T	DSk/ls
58	4103-7613	do.	do.	1957	P	500	T	Do/lss
59	4103-7613	do.	do.	1957	P	500	T	Do/lss
60	4107-7631	Jerre Wright	---	---	C	630	V	Dmh/sh
61	4056-7627	Catawissa Water Authority	---	---	P	480	V	Dcsc/sssh
62	4056-7627	do.	---	---	P	485	V	Dcsc/sssh
63	4059-7626	Bloomsburg Packing Co.	Kohl Brothers	1946	N	480	V	Dmr/sh
66	4104-7624	Orangeville Water Co.	R. R. Hornberger	1963	P	670	W	Dcsc/sssh
68	4103-7614	Consolidated Cigar Corp.	Joseph Wright	1957	A	540	T	Swc/dls
69	4103-7614	do.	do.	1957	A	540	T	Swc/dls
70	4103-7615	Keystone Water Co.	Cresswell	1957	P	525	T	Swc/dls
84	4057-7627	Catawissa Water Authority	---	---	P	475	V	Dcsc/sssh
85	4057-7627	do.	Alvin Swank and Son	1981	P	480	V	Dcsc/sssh
86	4102-7619	Scenic Knolls	---	1950	P	605	S	Swc/dls
87	4102-7619	do.	---	1964	P	610	S	Swc/dls
88	4102-7619	do.	R. R. Hornberger	1966	P	675	S	Sb/sh
90	4104-7619	Yohey	Champion	1978	H	980	H	Dciv/sh
91	4100-7621	G. Breisch	do.	1978	H	920	H	Dtr/sssh
92	4101-7621	J. Johnson	Stackhouse	1972	H	500	V	Dmr/sh
93	4100-7618	Pete Diehl	Champion	1977	H	670	S	Dciv/sssh
94	4100-7618	B. Diehl	do.	1977	H	740	S	Dciv/sssh
95	4104-7616	Steve Yeager	do.	1978	H	630	S	Dmh/sh
96	4105-7616	Stanley Belles	W. C. Fenstemaker	1970	H	970	S	Dcsc/sssh
97	4105-7616	Ronald Davis	Champion	1968	H	1,055	H	Dciv/sssh
98	4101-7618	Don Shrader	Roy Zimmerman	1967	H	510	T	Dmr/sh
99	4105-7620	Alan Nagle	Champion	1973	H	940	S	Dcsc/sssh
100	4105-7620	Edward Fink	do.	1971	H	930	S	Dcsc/sssh
101	4104-7621	Robert Markle	do.	1978	H	945	S	Dcsc/sssh
102	4101-7622	Bloomsburg Carpet	R. R. Hornberger	1966	N	495	T	DSk/ls
103	4103-7618	St. Peter's Church	do.	1967	H	700	H	Sb/sh
104	4100-7615	Pennsylvania Department of Transportation	do.	1966	H	880	S	Dcsc/sssh
105	4104-7618	---	do.	1966	H	500	T	Dmr/sh
106	4102-7621	D. Dickson	Stackhouse	1977	H	645	S	Swc/dls
108	4101-7620	Poloron	R. R. Hornberger	1970	N	510	V	Do/lss
109	4102-7622	Schultz Electroplating	do.	1973	N	705	S	Sb/sh
110	4102-7622	do.	do.	1973	N	705	S	Sb/sh
111	4106-7622	Fred Cleaver, Jr.	Clifton Buck	1968	H	616	T	Qgo/sg
112	4105-7624	Norpole	R. R. Hornberger	---	H	580	T	Qgo/sg
113	4105-7624	Raymond Ribble	Virgil Buck	1980	H	590	T	Dcsc/sssh
114	4106-7622	Ray Messersmith	Stackhouse	---	H	580	T	Dcsc/sssh
115	4104-7624	Keith Musselman	Champion	1975	H	920	S	Dcsc/sssh
116	4102-7624	Donald Thomas	Stackhouse	1973	H	690	H	Swc/dls
117	4103-7625	Judy Krumheller	do.	1972	H	550	S	Dcsc/sssh
118	4103-7623	Graig Gibney	Champion	1974	H	955	S	Dciv/sssh
119	4103-7625	Ed Campbell	Stackhouse	1977	H	555	S	Dcsc/sssh
120	4103-7624	R. Whitmeyer	Alvin Swank and Son	1979	H	1,000	S	Dtr/sssh
121	4102-7604	Charles Baylor	R. R. Hornberger	1973	H	820	S	Dtr/sssh
122	4104-7623	Edward Haugh	do.	1966	H	890	W	Dciv/sssh
123	4104-7623	James Cox	do.	1968	H	880	W	Dciv/sssh
124	4102-7624	Harry Wenner	Stackhouse	1977	H	775	S	Dmh/sh
125	4102-7624	Kingston	Champion	1975	H	650	S	Dmh/sh
126	4102-7625	Steve Truesdale	Ronald Randler	1978	H	620	W	Dmh/sh
127	4102-7625	Robert Beers	R. R. Hornberger	1977	H	530	T	Dmh/sh
128	4101-7624	Pennsylvania Power and Light Co.	do.	1972	C	720	S	Smk/lss
129	4101-7628	Carl Welliver	do.	1967	H	560	S	Dmh/sh
130	4101-7628	do.	---	---	H	520	V	Qgo/sg
131	4101-7628	Jim Kreamer	Clifton Buck	1974	H	615	S	Smk/sls
132	4100-7624	Joe Crawford	Stackhouse	1976	H	485	V	DSk/ls
133	4100-7624	Venice Koons	Champion	1970	H	485	V	Dmr/sh

(CONTINUED)

Total depth below land surface (feet)	Casing		Oep th(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (μmho/cm at 25°C)	Well number
	Oepth (feet)	Oiameter (inches)		Depth below land surface (feet)	Oate measured (mo/yr)						
COUNTY											
18	---	---	---	11	6/80	---	---	---	---	---	Co- 1
282	32	6	115;163	83	4/81	1	.03/1	1	---	480	45
12	---	---	---	---	---	60	---	---	---	---	47
202	48	8	---	42	1/30	---	5.6/185	24	---	---	48
205	14	10	---	11	8/80	---	1.2/45	3	---	---	49
498	94	8	---	25	3/58	---	3.2/542	8	---	---	51
550	115	10	---	35	11/64	---	13/1,170	24	462	980	52
420	77	12	---	30	11/64	---	3.8/620	24	---	---	53
500	21	8	---	---	---	60	.23/39	5	57	345	56
160	63	12	---	31	6/81	---	280/300	24	200	---	57
90	75	12	---	30	6/81	---	340/200	24	240	---	58
87	58	12	---	32	6/81	---	350/300	24	184	---	59
225	40	8	92;140;200	5	5/81	---	2.5/15	1	124	540	60
375	---	---	---	14	7/80	---	.19/8	1	---	---	61
275	14	6	---	11	8/80	---	.42/16	1	51	100	62
525	42	8	---	7	5/46	225	---	---	---	---	63
465	16	6	---	64	10/63	---	.39/28	25	---	---	66
284	---	10	---	---	---	200	---	---	---	---	68
151	---	10	---	---	---	---	---	---	---	---	69
473	75	12	120;140;260; 340;390;420; 450	37	5/81	380	5.3/83	1	240	675	70
250	28	8	---	---	---	55	---	---	---	---	84
448	30	8	30;60;95; 120;270	---	---	100	---	---	---	---	85
190	---	---	---	---	---	8	---	---	---	---	86
402	---	---	---	---	---	5	---	---	---	---	87
415	42	7	70;103;157	80	8/66	8	.02/---	---	---	---	88
275	20	6	205	---	---	5	---	---	---	---	90
200	20	6	125;160	---	---	6	---	---	---	---	91
70	22	6	42;68	---	---	30	---	---	290	470	92
165	20	6	130;158	48	9/81	15	---	---	34	90	93
150	20	6	135	---	---	5	---	---	---	---	94
150	44	6	130	---	---	10	---	---	---	---	95
75	40	6	60;70	---	---	20	---	---	---	---	96
100	20	6	74;98	---	---	5	---	---	---	---	97
120	71	6	---	---	---	12	---	---	68	183	98
150	20	6	120	---	---	---	---	---	---	---	99
100	20	6	75	25	5/71	15	---	---	---	---	100
125	90	6	105	---	---	8	---	---	17	51	101
95	36	6	60;90	---	8/66	40	.44/---	---	222	516	102
175	30	6	---	114	11/80	3	.04/---	---	102	200	103
80	47	6	75	32	5/66	30	1.7/---	---	---	---	104
67	50	6	62	20	12/66	30	2.0/---	---	---	---	105
173	21	6	110;165	101	11/80	---	---	---	120	140	106
300	184	8	130;220;280	34	7/70	350	1.1/200	24	254	600	108
390	27	6	---	40	6/73	9	---	---	---	---	109
495	21	6	---	40	6/73	5	---	---	---	---	110
47	46	6	---	18	7/68	20	1.7/---	---	51	101	111
33	34	6	33	13	---	50	---	---	34	82	112
62	55	6	62	24	4/76	20	---	---	51	70	113
120	---	---	---	12	6/80	---	---	---	68	125	114
175	70	6	105;150	80	6/80	7	---	---	17	50	115
151	98	6	150	---	---	14	---	---	---	---	116
61	31	6	38;60	---	---	8	---	---	85	135	117
100	40	6	75	7	6/80	12	---	---	17	100	118
193	42	6	165;190	---	---	8	---	---	68	120	119
400	60	6	175	---	---	1	---	---	34	58	120
215	20	6	---	48	---	5	---	---	---	---	121
75	33	6	---	7	10/66	8	.13/---	---	---	---	122
---	33	6	59;89;91	18	6/80	5	.07/---	---	---	---	123
223	50	6	190	40	4/77	---	---	---	103	218	124
125	65	6	105;116	---	---	8	---	---	---	---	125
100	100	6	---	43	6/80	13	---	---	34	65	126
66	36	6	40;63	5	4/77	30	---	---	---	---	127
200	41	6	---	6	10/72	---	.37/12	24	171	260	128
175	24	6	76;93;130	44	8/80	3	.02/---	---	137	185	129
---	---	---	---	2	6/80	---	---	---	68	90	130
125	50	6	105	100	10/74	10	1.00/---	---	51	75	131
47	27	6	47	3	4/76	10	1.4/---	---	308	380	132
53	35	6	45	15	3/70	30	---	---	---	---	133

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Co-134	4100-7624	Isola	Champion	1970	H	480	V	Dmr/sh
135	4101-7625	Donald Meckley	---	1967	H	750	S	Sru/sls
136	4100-7625	Amoco	Champion	1974	H	495	V	Sto/lsd
137	4100-7627	Mary Hill	Stackhouse	1978	H	84D	S	Sru/sls
138	4057-7626	Catawissa Water Authority	---	---	P	480	V	Dcsc/sssh
139	4056-7626	do.	Alvin Swank and Son	1979	P	780	W	Dcsc/sssh
140	4056-7626	do.	do.	1979	P	720	W	Dcsc/sssh
141	4101-7619	U.S. Geological Survey	---	1979	O	500	T	Qgo/sg
142	41D1-7618	do.	---	1979	O	505	T	Qgo/sg
143	4102-7617	do.	---	1979	O	490	T	Qgo/sg
144	4100-7618	do.	---	1979	U	570	S	Qt/sd
146	4102-7618	do.	---	1979	U	505	T	Qgo/sg
147	4102-7618	do.	---	1979	U	500	T	Qgo/sg
148	4102-7617	do.	---	1979	U	520	T	Qgo/slt
149	4102-7618	do.	---	1979	U	510	T	Qgo/sg
150	4103-7616	do.	---	1979	U	495	T	Qgo/sg
151	4104-7625	do.	---	1979	U	585	W	Qt/sd
152	4D59-7628	do.	---	1979	U	470	T	Qgo/sd
153	4059-7628	U.S. Geological Survey	---	1979	U	465	T	Qgo/sg
154	4059-7628	do.	---	1979	O	470	T	Qgo/sg
155	4056-7627	Susquehanna Dairy Association	---	---	N	520	S	Ocsc/sssh
156	4102-7625	Willard Thomas	Clifton Buck	1956	H	550	T	Swc/dls
157	4101-7624	James Magee	R. R. Hornberger	1968	H	785	S	Smk/sls
158	4102-7621	Robert Neyhard	do.	1966	H	760	H	Sb/sh
159	4102-7617	Harold Wertman	do.	1975	H	485	V	Swc/dls
160	4102-7617	do.	---	---	H	485	V	Qgo/sg
161	4101-7622	Bloomsburg Carpet Industries	R. R. Hornberger	1977	N	495	V	Sto/lsd
162	4101-7621	Col-Mont Vo-Tech	do.	1967	P	565	S	Swc/dls
163	4101-7622	Robert Holdren	do.	1966	H	500	V	Sto/lsd
164	4101-7622	John Wolf	---	1880	H	520	S	Swc/dls
165	4101-7621	Cindy Yorty	Alvin Swank and Son	198D	H	485	V	Dmh/sh
166	4101-7621	Claire Wagner	Stackhouse	1972	H	490	V	Dmh/sh
167	4101-7620	Gerald Young	R. R. Hornberger	1966	H	495	V	Omh/sh
168	4101-7619	Walter Hause	Alvin Swank and Son	1979	H	520	V	DSk/ls
169	4101-7619	John Horeck	Champion	1973	H	520	V	Sto/lsd
17D	4103-7614	Pennsylvania Department of Transportation	---	1977	U	548	T	Qgo/sg
173	41D3-7613	do.	---	1977	U	472	C	Do/lss
182	4101-7620	David Belles	Virgil Buck	1975	H	525	V	Oon/lss
183	4101-762D	Richard Huber	Champion	1976	H	515	V	Do/lss
184	4106-7637	Allen Gardner	Virgil Buck	1977	H	780	H	Omh/sh
185	4104-7614	Drew Heckman	Champion	1968	H	660	S	Omh/sh
186	4058-7628	J. Streater	R. R. Hornberger	1968	I	470	V	Omh/sh
187	4059-7628	L. Wintersteen	---	---	H	490	V	Dmr/sh
188	4059-7628	do.	---	1935	H	490	V	Oon/lss
189	4059-7626	Kawneer, Inc.	R. R. Hornberger	1966	N	470	V	Dmr/sh
190	4100-7626	do.	do.	1966	N	475	V	Omr/sh
191	4059-7624	Wonderview Water Co.	do.	1967	P	630	S	Otr/sssh
192	4059-7624	do.	---	---	P	760	S	Dtr/sssh
193	4D59-7624	do.	R. R. Hornberger	1977	P	760	S	Dtr/sssh
195	4103-7616	Joseph Alley	Champion	1972	H	515	V	Swc/dls
196	4101-7620	Champion Valley Farms	---	1963	N	500	T	Do/lss
197	4101-7621	do.	---	1963	N	500	T	Do/lss
198	4101-7621	do.	---	1964	N	500	T	Do/lss
199	4101-7621	do.	R. R. Hornberger	1968	N	500	T	Do/lss
200	4103-7637	Paul Whalon	Virgil Buck	1972	H	575	S	Dmh/sh
201	4103-7615	John OiBattista	Champion	1975	H	530	V	Swc/dls
2D2	4101-7620	Scott Sweeny	---	---	H	5D5	T	Qgo/sg
203	4101-7620	do.	---	---	H	505	T	Dmr/sh
204	4102-7619	Columbia County Development Authority	R. E. Kresge	1970	N	510	T	Swc/dls
2D5	4102-7619	do.	do.	1970	N	510	T	Swc/dls
206	4102-7617	Mifflin Township Water Authority	R. R. Hornberger	1971	P	490	T	Qgo/sg
2D7	4102-7617	do.	do.	1974	P	490	T	Qgo/sg
209	410D-7618	do.	Kohl Brothers	1970	P	600	W	Dcsc/sssh
210	4D56-7627	Catawissa Lumber Co.	---	---	N	550	S	Ocsc/sssh
211	4056-7627	do.	---	---	N	525	S	Ocsc/sssh
212	4101-762D	Helen Rupert	---	---	H	5D0	T	Dmr/sh
213	41D1-7620	do.	---	---	H	500	T	Qgo/sg
214	41D1-7625	Paul Eyerly	R. R. Hornberger	1978	H	695	H	Smk/sls
217	42D2-7617	Lupini	---	---	H	505	T	Dmr/sh
218	4106-7633	R. Eckroth	Stackhouse	1978	H	740	S	Dmh/sh

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
75	30	6	40;60	20	3/70	12	---	---	---	---	Co-134
280	51	6	210;270	60	1/67	8	---	---	111	220	135
75	40	6	52	5	6/80	15	---	---	---	---	136
173	61	6	165	33	6/80	8	.10/3	1	68	85	137
---	---	---	---	---	---	---	---	---	---	---	138
400	43	8	---	---	---	60	.16/45	48	---	---	139
400	42	8	135;270	---	---	60	.22/55	48	---	---	140
37	32	2	---	20	6/80	---	---	---	---	---	141
47	42	2	---	23	6/80	---	---	---	---	---	142
62	57	2	---	21	6/80	---	---	---	---	---	143
---	---	---	---	---	---	---	---	---	---	---	144
---	---	---	---	---	---	---	---	---	---	---	146
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40	35	2	---	12	6/80	---	---	---	---	---	154
200	---	---	---	---	---	---	---	---	---	---	155
68	63	6	---	---	---	---	---	---	135	220	156
73	41	6	67	43	6/80	20	1.1/---	---	51	135	157
215	18	6	90;148;174	50	6/66	15	---	---	103	210	158
70	24	6	---	16	6/80	12	---	---	290	515	159
30	---	---	---	17	6/80	---	---	---	256	345	160
40	17	6	---	10	12/80	---	---	---	---	---	161
155	74	6	89;130;148	53	6/80	---	1.8/40	48	---	---	162
95	22	6	45;71;90	1	8/66	12	.13/---	---	325	360	163
25	---	---	---	13	6/80	---	---	---	307	455	164
175	---	---	---	13	6/80	2	---	---	256	380	165
60	47	6	59	---	---	14	---	---	290	420	166
63	31	6	50	25	6/80	3	.08/---	---	188	260	167
80	72	6	---	49	6/80	35	---	---	222	360	168
100	40	6	85	---	---	7	---	---	---	---	169
---	---	---	---	---	---	---	---	---	---	---	170
---	---	---	---	---	---	---	---	---	---	---	173
80	50	6	50;80	---	---	10	---	---	188	280	182
225	40	6	175	30	6/80	5	---	---	137	205	183
275	20	6	100;200;250	---	---	3	---	---	---	---	184
75	20	6	---	F	8/68	12	---	---	---	---	185
500	32	8	35;70;165; 360;470	12	7/68	---	1.4/250	12	---	---	186
86	---	---	---	16	7/80	30	18/32	1	188	490	187
119	---	---	---	---	---	12	---	---	308	820	188
355	26	6	41;59;94;177	30	12/66	---	.06/20	3	---	---	189
415	24	10	40;68;118; 156;308	6	7/80	100	.41/20	1	120	2,500	190
395	81	6	92;109;132; 261	35	1/67	30	.11/28	48	---	---	191
375	---	---	265;335;367	---	---	---	.10/15	48	---	---	192
410	62	6	---	---	---	30	---	---	---	---	193
75	31	6	53	21	7/80	10	---	---	---	---	195
268	45	7	---	47	7/80	80	---	---	---	---	196
550	41	12	---	---	---	250	---	---	---	---	197
600	40	8	---	---	---	440	---	---	---	---	198
500	43	10	50;170;180	25	6/68	---	1.3/218	24	---	---	199
92	21	6	85;92	---	---	6	---	---	---	---	200
100	70	6	70	35	8/80	---	1.9/10	1	154	400	201
34	---	---	---	33	7/80	---	---	---	---	---	202
110	---	---	---	38	12/80	---	---	---	170	400	203
273	---	---	---	31	10/80	85	7.4/141	48	180	430	204
248	62	6	130;160;190	32	8/80	77	1.1/136	48	---	---	205
60	57	6	---	29	8/80	85	11/55	---	---	---	206
63	53	8	---	---	---	70	4.4/102	---	---	---	207
310	70	8	80;200	42	8/70	12	.06/---	---	---	---	209
500	---	---	---	78	8/80	3	---	---	86	295	210
465	---	---	---	---	---	3	---	---	120	300	211
120	55	6	78;93;117	32	12/80	---	.50/16	2	137	340	212
33	---	---	---	20	9/80	---	---	---	---	---	213
315	37	6	180;300	90	1/78	2	---	---	---	---	214
65	---	---	---	52	12/80	---	---	---	137	250	217
348	21	6	110	---	---	1	---	---	137	360	218

TABLE 23.

Well location								
Number	Lat-Long	Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Co-219	4105-7633	Dale Stiner	R. R. Hornberger	1967	H	845	H	Dmh/sh
220	4106-7633	S and S Auto Works	Clifton Buck	1978	H	660	V	Dmh/sh
222	4106-7633	Ted Heaps	Stackhouse	1980	H	670	V	Dmh/sh
223	4106-7633	do.	do.	1980	H	680	V	Dmh/sh
224	4106-7633	do.	do.	1980	H	675	V	Dmh/sh
226	4106-7633	James Nolan	Virgil Buck	1978	H	750	H	Dmh/sh
227	4104-7630	Stackhouse	Stackhouse	1978	H	800	S	Dtr/sssh
228	4103-7631	Dave Ortman	do.	1978	H	1,000	H	Dtr/sssh
229	4103-7631	do.	---	---	H	1,000	H	Dtr/sssh
230	4103-7631	Jack Rowe	Stackhouse	1973	H	985	H	Dtr/sssh
231	4102-7631	Roy Ruckle	Clifton Buck	1975	H	750	V	Dtr/sssh
232	4102-7631	do.	do.	1960	H	770	V	Dtr/sssh
233	4102-7631	do.	Stackhouse	1978	H	770	V	Dtr/sssh
234	4106-7631	Charles Laver	Clifton Buck	1974	H	795	S	Dmh/sh
235	4106-7631	Stine	---	---	H	620	V	Dmh/sh
236	4104-7631	do.	R. R. Hornberger	1980	S	760	V	Dtr/sssh
237	4103-7632	Eckroth	Virgil Buck	1969	H	940	H	Dtr/sssh
238	4104-7630	Frank Stackhouse	Stackhouse	1973	C	775	C	Dtr/sssh
239	4104-7630	do.	do.	1963	H	770	V	Dtr/sssh
240	4103-7631	Sandler	---	---	H	930	S	Dtr/sssh
241	4104-7631	L. Millard	Stackhouse	1978	H	980	H	Dciv/sssh
242	4104-7631	Duane Bardo	do.	1974	S	760	S	Dtr/sssh
243	4103-7632	David Bowers	Stackhouse	1973	H	840	S	Dtr/sssh
244	4103-7632	Dutch Hill Church	do.	1977	H	935	S	Dtr/sssh
245	4057-7627	Catawissa Bottling	Alvin Swank and Son	1981	N	550	W	Dcsc/sssh
246	4104-7630	Randy Lawton	Stackhouse	1972	H	590	S	Dciv/sssh
248	4104-7636	James Cyphers	Ronald Randler	1966	H	555	V	Dmh/sh
249	4104-7634	Dale Zeisloft	Stackhouse	---	H	645	S	Dmh/sh
250	4105-7634	Donald Zeisloft	Clifton Buck	1974	H	680	S	Dmh/sh
251	4104-7634	Steve Zeisloft	do.	1975	H	650	S	Dmh/sh
252	4102-7633	Urlich	Stackhouse	1978	H	1,050	H	Dtr/sssh
253	4103-7635	Myron Diehl	Clifton Buck	1967	H	940	S	Dtr/sssh
254	4105-7634	Rishel	do.	1980	H	635	W	Dmh/sh
255	4106-7631	Jerry Boone	do.	---	H	740	H	Dmh/sh
256	4135-7606	Raymond Williams	R. R. Hornberger	1966	H	745	S	Dmh/sh
257	4106-7633	William Schneeweis	do.	1976	H	720	S	Dmh/sh
258	4107-7632	Dale Stackhouse	Virgil Buck	1978	H	805	H	Dmh/sh
301	4100-7622	U.S. Radium Corp.	Wieand Brothers	1979	O	490	T	Qgo/sg
302	4100-7622	do.	do.	1980	O	490	T	Qgo/sg
303	4100-7622	do.	do.	1979	O	490	T	Qgo/sg
304	4102-7617	U.S. Geological Survey	Alvin Swank and Son	1980	O	490	T	Sto/lsd
305	4101-7618	do.	do.	1980	O	515	T	Qgo/sg
306	4101-7621	do.	do.	1980	O	490	T	Dmr/sh
307	4102-7616	do.	do.	1980	O	505	T	Sto/lsd
308	4102-7616	do.	do.	1980	O	495	T	Qgo/sg
309	4102-7618	R. Lupini	---	---	H	510	T	Dmr/sh
310	4100-7626	William Coombs	Alvin Swank and Son	1980	C	490	T	DSk/ls
311	4101-7618	Foster Hudelson	---	---	H	510	T	Qgo/sg
312	4058-7631	Ray Gross	R. R. Hornberger	1968	H	630	S	Don/lss
313	4101-7616	Wilkes Pools	---	---	C	880	S	Dscs/sssh
314	4058-7631	Lycoming Sand Co.	Champion	1977	H	645	V	DSk/ls
315	4059-7630	James Roth	R. R. Hornberger	1977	H	700	S	Sb/sh
316	4102-7620	Arden Sitler	Champion	1970	H	740	S	Sb/sh
317	4103-7619	Orvil Weaver	do.	1972	H	745	T	Dh/sh
318	4103-7619	do.	do.	1976	H	740	T	Dmh/sh
320	4103-7619	Charles Sheatler	---	1971	U	720	T	Dmh/sh
321	4103-7619	do.	---	1976	H	720	T	Dmh/sh
322	4103-7619	do.	Champion	1976	H	705	T	Dmh/sh
323	4103-7619	Powlus	do.	1971	H	580	V	Swc/dls
324	4103-7619	C. Hornberger	do.	1971	H	585	V	Swc/dls
325	4103-7619	James Powlus	do.	1971	H	585	V	Swc/dls
326	4103-7618	Carl Strausser	---	1958	H	560	V	Swc/dls
327	4103-7618	Jesse Traugh	R. R. Hornberger	1967	H	540	V	Swc/dls
328	4103-7619	Orvil Weaver	Champion	1972	H	750	T	Dh/sh
329	4102-7613	Lew Andrezzi	do.	1969	H	500	T	Dmh/sh
330	4100-7624	Liberty Chevrolet	---	---	H	490	T	Sto/lsd
331	4059-7628	Jeff Fritz	Stackhouse	1980	H	500	V	Smk/sls
332	4059-7629	Bell Telephone Co.	Wieand Brothers	1974	C	500	V	Smk/sls
333	4104-7614	Randall Kishbaugh	Champion	1978	H	800	S	Dmh/sh
334	4104-7614	do.	do.	1975	H	805	S	Dmh/sh
335	4104-7618	O. Tyson	do.	1977	H	700	S	Dmh/sh
336	4104-7618	Slovic	do.	1975	H	785	S	Dh/sh
337	4104-7615	Eskin	Roy Zimmerman	1967	H	710	S	Dmh/sh
340	4103-7618	Ralph Kelchner	Champion	1972	H	580	T	DSk/ls
341	4103-7618	Lillian Robbins	do.	1974	H	570	T	Swc/dls

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
205	21	6	25;63	26	9/80	2	.03/---	---	120	285	Co-219
320	---	---	---	10	9/80	---	.03/5	1	17	750	220
300	20	6	---	12	9/80	1	.03/1	1	17	775	222
---	20	6	---	18	9/80	1	---	---	---	---	223
---	20	6	---	15	9/80	1	---	---	---	---	224
185	40	6	130;175	18	9/80	4	.03/---	---	188	520	226
---	---	---	---	40	10/80	---	---	---	68	190	227
---	---	---	---	---	---	2	---	---	51	130	228
---	---	---	---	31	10/80	---	---	---	34	78	229
72	---	---	---	---	---	---	---	---	51	135	230
30	20	6	27	---	---	1	.06/---	---	---	---	231
80	---	---	---	---	---	---	---	---	34	92	232
40	---	---	---	---	---	---	---	---	51	210	233
90	20	---	65;87	---	---	6	.07/---	---	188	360	234
---	---	---	---	---	---	---	---	---	120	350	235
---	---	---	---	---	---	---	---	---	51	144	236
65	---	---	---	---	---	---	---	---	34	92	237
123	---	---	---	13	10/80	---	---	---	34	165	238
123	---	---	---	15	10/80	---	---	---	34	125	239
240	---	---	---	37	11/80	---	---	---	---	---	240
123	41	6	118	---	---	10	---	---	---	---	241
200	21	6	180	1	10/80	12	---	---	51	200	242
104	21	6	101	---	---	6	---	---	51	195	243
142	40	6	62;128	49	11/80	15	---	---	34	58	244
440	40	8	72;94;204; 412	32	2/81	---	.12/40	22	120	385	245
90	28	6	85	---	---	8	---	---	---	---	246
90	22	6	55;85	10	7/66	4	.05/---	---	---	---	248
420	---	---	---	16	11/80	---	---	---	103	315	249
123	22	6	70;120	27	11/80	10	.15/---	---	86	305	250
70	20	6	65	32	5/75	6	.20/---	---	---	---	251
175	---	---	---	40	11/80	---	---	---	---	120	252
55	20	6	51	19	5/67	6	.21/---	---	---	---	253
60	---	---	---	12	11/80	---	---	---	120	385	254
130	52	6	80;130	---	---	---	---	---	---	---	255
115	21	6	45;65;108	15	6/66	5	.05/---	---	---	---	256
175	20	6	30	8	10/76	---	---	---	---	---	257
140	22	6	110;130	30	2/78	6	.06/---	---	137	420	258
35	35	6	---	---	---	---	---	---	---	---	301
35	30	6	---	---	---	---	---	---	---	---	302
37	37	6	---	---	---	---	---	---	---	---	303
200	58	6	73;86;97; 182	28	12/80	100	21/19	1	154	280	304
68	68	6	---	32	12/80	50	10/38	6	54	118	305
---	42	6	60;74	21	6/81	25	1.7/17	1	188	395	306
300	47	6	62;96;116; 150;275	37	12/80	120	89/20	1	428	800	307
53	50	---	---	26	7/81	6	1.4/12	1	---	800	308
69	40	6	---	38	9/80	---	.44/5	1	86	220	309
360	40	8	---	21	12/80	250	3.9/75	1	19	730	310
35	---	---	---	32	10/80	---	---	---	---	---	311
52	22	6	42	15	6/68	9	.24/---	---	---	---	312
---	---	---	---	---	---	---	---	---	---	---	313
150	45	6	130	---	---	---	---	---	---	---	314
95	20	6	90	10	11/77	---	---	---	---	---	315
175	20	6	75;145	---	---	8	---	---	---	---	316
75	40	6	40;63	8	7/72	6	---	---	---	---	317
100	20	6	70	---	---	8	---	---	---	---	318
100	---	---	---	27	11/80	---	---	---	---	---	320
200	---	6	---	35	11/80	---	---	---	137	340	321
150	20	6	127	---	---	15	---	---	---	---	322
40	40	6	---	8	11/80	---	---	---	---	---	323
50	30	6	45	---	---	20	---	---	---	---	324
50	---	6	45	12	2/71	20	---	---	---	---	325
85	16	6	---	15	11/80	10	---	---	154	435	326
93	80	6	88	7	10/67	50	3.9/---	---	---	---	327
100	40	6	75	50	8/72	5	---	---	---	---	328
125	28	6	100;115	---	---	10	---	---	---	---	329
---	---	---	---	11	12/80	20	---	---	---	345	330
125	30	6	---	12	12/80	5	---	---	103	300	331
350	43	6	84;262	2	11/74	---	.13/30	48	68	280	332
150	20	6	---	31	12/80	---	---	---	---	---	333
100	20	6	80	44	12/80	10	---	---	---	---	334
150	20	6	130	50	12/80	8	---	---	---	---	335
100	40	6	85	36	12/80	---	---	---	---	---	336
133	26	6	88;100;128	---	---	10	---	---	---	---	337
75	22	6	48	23	11/72	14	---	---	---	---	340
75	45	6	55	15	8/74	20	---	---	---	---	341

TABLE 23.

Well location								
Number	Lat-Long	Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Co-342	4103-7619	Bertie Dennis	Clifton Buck	1967	H	565	W	Dmh/sh
343	4103-7619	Nelson Kulf	do.	1967	H	605	S	Dmh/sh
344	4101-7620	Columbia County Development Authority	---	1977	U	515	T	Qgo/sg
345	4102-7619	do.	---	1977	U	510	T	Qgo/sg
346	4102-7619	do.	---	1977	U	520	T	Qgo/sg
347	4101-7619	do.	---	1977	U	520	T	Qgo/sg
348	4102-7619	Robert Krum	Stackhouse	1980	H	510	T	Do/lss
349	4101-7619	do.	---	---	H	510	T	Do/lss
350	4058-7630	W. Diehl	R. R. Hornberger	1960	H	910	H	Otr/sssh
351	4058-7630	R. Fetterman	Wieand Brothers	1960	---	575	S	Dmh/sh
353	4100-7631	R. Snyder	Stackhouse	1973	H	625	S	Dmh/sh
354	4100-7632	Eugene Wagner	R. R. Hornberger	1966	C	880	W	Dtr/sssh
355	4101-7625	James Vance	---	---	H	700	H	Smk/sls
356	4103-7623	Robert Thomas	Alvin Swank and Son	1976	H	755	S	Dmh/sh
357	4102-7622	Roland Michael	---	1940	H	735	W	Sb/sh
358	4102-7624	Hock	---	---	H	670	S	Sb/sh
359	4102-7624	do.	---	---	H	700	S	Sb/sh
360	4102-7621	B. F. Haney	Clifton Buck	1969	H	640	W	Swc/dls
361	4102-7622	Robert Eckrote	do.	1968	H	630	S	Swc/dls
362	4103-7621	George Acornley	Alvin Swank and Son	1975	H	700	S	Dmh/sh
363	4057-7628	Charles Karns	---	---	H	480	V	Dcsc/sssh
364	4058-7629	Mildred Oeussen	---	---	H	860	H	Dtr sssh
365	4058-7627	Pierce Breech	---	---	H	775	H	Otr/sssh
366	4059-7626	Fay Young	Alvin Swank and Son	1973	H	825	H	Dtr/sssh
367	4058-7626	Charles Creasy	---	---	H	830	H	Dtr/sssh
368	4058-7625	William Slusser	Clifton Buck	---	H	885	H	Dtr/sssh
369	4104-7616	Kenneth Helm	---	---	H	640	S	Dmh/sh
370	4104-7615	Jay Welsh	Champion	1976	H	675	S	Dmh/sh
371	4102-7622	Benard Bafile	Stackhouse	1978	H	745	S	Sb/sh
372	4103-7629	Clair Hock	Clifton Buck	1971	C	540	V	Ocsc/sssh
373	4059-7627	ARCO	Wieand Brothers	1980	O	480	T	Swc/dls
374	4104-7617	John Fester	R. R. Hornberger	1967	H	680	T	Dmh/sh
375	4106-7628	George Duncan	Virgil Buck	1977	H	730	S	Omh/sh
376	4106-7628	do.	do.	1963	H	700	W	Dmh/sh
377	4104-7628	N. Gross	do.	1978	H	1,010	H	Ociv/sssh
378	4105-7626	Richard Puterbaugh	R. R. Hornberger	1966	H	945	S	Ociv/sssh
379	4105-7624	Matthew Zoppetti	---	1971	H	580	V	Qgo/sg
380	4107-7632	Millville Water Authority	---	1980	P	630	V	Qal/sg
381	4102-7624	William Botke	Alvin Swank and Son	---	H	760	S	Sto/lsd
382	---	---	---	---	H	585	V	Dmh/sh
383	4106-7626	Amos Harvey	Clifton Buck	1976	H	970	S	Dtr/sssh
384	4106-7626	P. Cain	Virgil Buck	1978	H	1,005	S	Dtr/sssh
385	4107-7625	Calvin Brown	Clifton Buck	1967	H	635	V	Dmh/sh
386	4106-7624	Joseph White	do.	1974	H	810	H	Dtr/sssh
387	4103-7625	R. Kile	Stackhouse	1978	H	785	S	Dcsc/sssh
388	4105-7627	Francis Purcell	Clifton Buck	1974	H	860	S	Dciv/sssh
389	4103-7615	Sam's Auto Sales	---	1981	H	520	T	Swc/dls
390	4104-7628	Robert Dewald	Clifton Buck	1968	H	945	H	Dcsc/sssh
391	4104-7628	Carl Shaner	R. R. Hornberger	1966	H	890	W	Dcsc/sssh
392	4104-7628	Harry Welliver	Clifton Buck	1967	H	940	H	Ociv/sssh
393	4103-7628	Howard Funk	do.	1967	H	960	H	Dcsc/sssh
394	4102-7628	Charles Turner	R. R. Hornberger	1966	H	820	H	Otr/sssh
395	4104-7629	David Walters	---	1974	H	655	V	Dtr/sssh
396	4104-7630	do.	---	1974	H	585	V	Ociv/sssh
397	4104-7630	do.	Clifton Buck	1974	H	585	V	Dciv/sssh
398	4103-7629	Columbia Asphalt Co.	---	---	H	620	S	Dcsc/sssh
399	4103-7629	do.	---	---	C	590	S	Ocsc/sssh
400	4104-7615	John Magrone	---	---	H	565	W	Qgo/sg
401	4104-7615	do.	J. F. Harrison	1979	H	565	W	Dmr/sh
402	4102-7618	Briar Heights Lodge	R. R. Hornberger	1976	C	590	W	Sb/sh
404	4100-7629	Quality Inn	do.	1973	C	645	H	Swc/dls
405	4101-7630	Joseph Levan	Stackhouse	1972	H	590	W	Dmh/sh
406	4105-7615	Rothery	Champion	1974	H	1,055	S	Dciv/sssh
407	4106-7621	Earl Eveland	R. R. Hornberger	1977	H	635	V	Qgo/sg
408	4104-7620	Donald Miller	do.	1966	H	685	W	Otr/sssh
409	4105-7624	Matthew Zoppetti	---	1973	H	575	V	Qgo/sg
410	4101-7629	Craig Laidacker	R. R. Hornberger	1966	H	475	W	Sto/lsd
411	4104-7628	George Crawford	Stackhouse	1975	H	950	H	Dcsc/sssh
412	4101-7627	Barbara Pfleegor	R. R. Hornberger	1973	H	585	W	Dmh/sh
413	4100-7625	Mariano Construction Co.	Stackhouse	1981	H	500	V	Swc/dls
414	4105-7615	Richard Oent	Champion	1974	H	1,015	S	Dciv/sssh
415	4105-7615	Edward Shultz	do.	1976	H	1,030	S	Dciv/sssh
416	4105-7615	Alex Keris	do.	1975	H	1,020	S	Dciv/sssh
417	4105-7615	Edmund Persans	do.	1974	H	1,020	S	Dciv/sssh
418	4105-7615	Harold Grasley	do.	1972	H	1,050	H	Ocsc/sssh
419	4105-7615	Drue Hoffman	---	1966	H	1,040	S	Dciv/sssh
420	4105-7615	Gary Kreischer	Champion	1977	H	980	S	Dciv/sssh

(CONTINUED)

Total depth below land surface (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Depth(s) to water-bearing zone(s) (feet)	Static water level: Depth below land surface (feet)	Static water level: Date measured (mo/yr)	Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
46	25	6	42	7	5/67	9	.26/---	---	---	---	Co-342
65	40	6	61	28	5/67	10	.43/---	---	---	---	343
25	23	6	---	---	---	---	---	---	---	---	344
25	20	6	---	---	---	---	---	---	---	---	345
25	24	6	---	---	---	---	---	---	---	---	346
25	---	---	---	---	---	---	---	---	---	---	347
120	85	6	---	---	---	6	---	---	---	---	348
54	39	6	---	---	---	---	---	---	---	---	349
303	35	6	---	67	12/80	1	---	---	---	---	350
98	---	---	---	19	11/78	---	---	---	---	---	351
147	30	6	---	26	12/78	---	---	---	---	---	353
300	29	7	82;198;258	48	10/78	30	.12/---	---	51	101	354
---	---	---	---	57	12/80	---	---	---	51	169	355
125	75	6	---	50	12/80	---	---	---	---	---	356
115	18	6	---	45	12/80	---	---	---	---	---	357
---	---	---	---	37	12/80	---	---	---	---	---	358
---	---	---	---	13	12/80	---	---	---	---	---	359
81	---	---	---	25	12/80	---	---	---	---	---	360
47	28	6	45	18	8/68	20	1.3/---	---	---	---	361
125	20	6	---	28	12/80	---	---	---	---	---	362
82	---	---	---	33	12/80	---	---	---	---	---	363
---	---	---	---	32	12/80	---	---	---	51	109	364
160	---	---	---	66	12/80	---	---	---	51	98	365
300	---	---	---	31	12/80	---	---	---	---	---	366
---	---	---	---	31	12/80	---	---	---	---	---	367
120	32	6	---	42	12/80	---	---	---	---	---	368
150	55	6	---	14	12/80	---	---	---	---	---	369
125	40	6	70;120	43	12/80	---	---	---	---	---	370
174	---	---	---	37	3/81	---	.18/3	1	51	110	371
85	---	---	---	9	4/81	---	.67/17	2	51	177	372
---	---	---	---	15	4/81	---	---	---	---	---	373
115	35	6	75;85;108	75	5/67	8	.20/---	---	---	---	374
130	23	6	90;120	17	5/81	7	.06/---	---	103	210	375
68	20	6	---	17	5/81	---	---	---	137	340	376
170	32	6	87;155	56	6/81	7	.06/---	---	17	45	377
90	45	6	50;78	27	5/81	5	.14/---	---	34	63	378
45	45	6	---	---	---	---	---	---	34	94	379
18	18	48	---	---	---	100	---	---	34	140	380
200	184	6	---	139	5/81	70	4.9/7	1	---	---	381
320	---	---	---	F	1/81	---	---	---	---	4500	382
100	31	6	60;100	---	---	4	---	---	---	---	383
230	20	6	175;210	90	12/78	5	.04/---	---	---	---	384
51	40	6	48	12	9/67	21	1.1/---	---	34	85	385
207	23	6	175	145	11/74	4	.06/---	---	68	125	386
248	62	6	123;241	---	---	20	---	---	34	104	387
76	47	6	72	28	9/74	8	.17/---	---	---	---	388
---	---	---	---	38	5/81	---	---	---	180	495	389
133	23	6	78;130	64	12/68	7	.12/---	---	---	---	390
175	20	6	71;138	---	---	8	---	---	68	160	391
134	---	6	77;130	71	11/67	10	.18/---	---	34	86	392
127	20	6	94;125	72	4/67	10	.20/---	---	---	---	393
255	23	6	176	67	8/66	2	.03/---	---	51	110	394
56	41	6	56	---	---	---	---	---	---	---	395
50	30	6	45	---	---	7	---	---	---	---	396
50	30	6	43	8	8/74	10	.37/---	---	---	---	397
---	---	---	---	29	4/81	---	---	---	---	---	398
---	---	---	---	60	4/81	---	---	---	---	---	399
30	---	---	---	23	5/81	---	---	---	---	---	400
67	65	6	65	28	5/81	40	4.0/---	---	---	---	401
414	20	6	---	19	2/76	200	---	---	---	---	402
179	106	10	---	69	5/73	75	---	---	154	300	404
75	29	6	74	---	---	17	---	---	51	148	405
100	40	6	80	---	---	8	---	---	---	---	406
40	43	6	---	19	1/77	15	---	---	---	---	407
435	24	6	45;97;376	15	6/66	3	---	---	34	300	408
64	64	6	---	10	4/73	20	1.00/---	---	---	---	409
63	30	6	60	34	10/66	10	.53/---	---	189	425	410
198	21	6	198	93	6/81	6	---	---	51	120	411
31	22	6	---	6	6/81	30	---	---	---	---	412
73	---	---	---	9	6/81	20	3.6/8	1	137	320	413
150	21	6	115	---	---	6	---	---	---	---	414
175	75	6	135	---	---	6	---	---	---	---	415
150	60	6	120	---	---	7	---	---	---	---	416
175	60	6	154	---	---	10	---	---	17	47	417
150	20	6	133	76	6/81	8	---	---	34	71	418
130	106	6	110;125	65	10/66	7	.13/---	---	86	200	419
100	70	6	78	---	---	8	---	---	---	---	420

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Co-421	4105-7615	William Kreischer	Champion	1977	H	890	S	Dciv/sssh
422	4106-7616	Camp Louise	do.	1969	H	1,120	S	Mmc/sssh
423	4107-7616	do.	---	---	H	1,130	S	Mmc/sssh
424	4105-7615	Eugene Collins	Champion	1970	H	1,040	H	Dciv/sssh
425	4106-7615	Kenneth Hess	do.	1973	H	1,020	S	Dcsc/sssh
426	4106-7615	Donald Lynn	do.	1973	H	990	S	Dcsc/sssh
427	4106-7616	Leonard Wilkinson	do.	1974	H	930	S	Dcsc/sssh
428	4105-7616	Lester Seely	do.	1975	H	925	S	Dciv/sssh
429	4104-7617	Lewis Abrams	R. R. Hornberger	1977	H	900	S	Dtr/sssh
430	4106-7616	David Hook	Champion	1974	H	940	S	Dcsc/sssh
431	4105-7616	Joseph Zowalski	do.	1972	H	985	S	Dcsc/sssh
432	4105-7616	Kenneth Slusser	do.	1974	H	990	S	Dcsc/sssh
433	4105-7616	David Whitenight	do.	1977	H	960	S	Dciv/sssh
434	4105-7616	John Stevens	do.	1976	H	950	S	Dciv/sssh
435	4106-7614	Jack Dent	do.	1973	H	1,000	S	Dciv/sssh
436	4104-7625	Klingerman Boarding	---	1960	H	580	V	Dcsc/sssh
437	4101-7625	Light Street Grange	---	1929	H	595	S	Sb/sh
438	4106-7614	Curtis Fultz	Champion	1972	H	1,020	S	Dciv/sssh
439	4106-7614	Jack Beck	do.	1973	H	980	W	Dcsc/sssh
440	4105-7613	Reba Richards	---	---	H	710	W	Dtr/sssh
441	4101-7621	Gary Swisher	---	---	H	500	T	Don/lss
443	4101-7621	William Jones	---	---	H	500	T	Dmr/sh
446	4101-7621	Baker Trailer Park	---	---	P	520	S	Sto/lss
448	4101-7621	Champion Valley Farms	Wieand Brothers	1981	N	500	T	Do/lss
452	4101-7622	Bloomsburg Water Co.	R. R. Hornberger	1967	P	500	T	Dmr/sh
453	4101-7627	Gary Hock	Alvin Swank and Son	1979	H	650	S	Swc/dls
454	4101-7627	Thomas Shaffer	---	1980	H	610	S	Dmh/sh
455	4102-7622	E. O. Franz, Sr.	---	1960	H	695	S	Sb/sh
456	4101-7627	Columbia County Waste Authority 1	Stackhouse	1974	O	640	W	Sto/lsd
457	4101-7627	Columbia County Waste Authority 4	---	---	H	650	S	Swc/dls
458	4101-7627	Columbia County Waste Authority 5	Stackhouse	1974	O	655	S	Swc/dls
459	4101-7627	Columbia County Waste Authority 6	do.	1974	O	665	H	Sto/lsd
460	4101-7627	Columbia County Waste Authority 7	do.	1974	D	530	W	Sb/sh
461	4101-7627	Columbia County Waste Authority 8	do.	1974	O	640	W	Sb/sh
462	4101-7627	M. Anderson	---	---	H	490	V	Sb/sh
463	4101-7627	Shultz	---	---	H	490	V	Sb/sh
464	4100-7614	Cy Mowery	R. R. Hornberger	1966	H	1,025	S	Dcd/sssh
465	4100-7614	Lee Schell	---	1976	H	930	H	Dcsc/sssh
466	4102-7613	Richard Yoder	Champion	1974	H	782	S	Dtr/sssh
467	4101-7620	Helen Rupert	---	1981	H	500	T	Dmr/sh
468	4101-7620	do.	---	1981	H	500	T	Dmr/sh
469	4106-7613	William Carrathers	Champion	1972	H	1,010	S	Dcsc/sssh
470	4106-7613	Martin Carrathers	do.	1972	H	982	S	Dcsc/sssh
471	4100-7614	Pennsylvania Department of Transportation	R. R. Hornberger	1966	H	835	W	Dcsc/sssh
472	4101-7614	Arlen Payne	Champion	1974	H	804	S	Dciv/sssh
473	4105-7618	Frank Rivera	---	1975	H	950	S	Dcsc/sssh
474	4105-7618	Jay Welsh	Champion	1974	H	940	S	Dcsc/sssh
501	4105-7618	David Laubach	do.	1973	H	950	S	Dcsc/sssh
502	4103-7617	Briar Creek Park	Alvin Swank and Son	1973	P	670	H	Swc/dls
503	4105-7617	Darvin Bower	Champion	1977	H	1,010	S	Dcsc/sssh
504	4105-7618	John Hrinda	---	1958	H	880	W	Dcsc/sssh
505	4101-7621	Champion Valley Farms	Wieand Brothers	1981	N	500	T	Sto/lsd
506	4104-7619	Wayne Girton	Champion	1975	H	950	S	Dcsc/sssh
507	4105-7618	Clarence O'Neal	do.	1973	H	975	H	Dcsc/sssh
508	4105-7618	Robert Gower	do.	1972	H	965	H	Dcsc/sssh
509	4105-7618	Doyle Keck	do.	1972	H	980	H	Dcsc/sssh
510	4105-7617	William Farrell	do.	1973	H	970	H	Dcsc/sssh
511	4105-7617	Karl Pennebaker	do.	1974	H	1,000	S	Dcsc/sssh
512	4105-7618	John Shultz	do.	1978	H	940	S	Dcsc/sssh
513	4105-7618	Shultz	do.	1974	H	950	S	Dcsc/sssh
514	4104-7617	Thelma Keck	do.	1972	H	750	S	Dciv/sssh
515	4104-7617	do.	Stackhouse	1979	H	750	S	Dciv/sssh
516	4105-7618	Rodney Diehl	Champion	1972	H	910	S	Dcsc/sssh
517	4105-7618	Cindy Weaver	do.	1974	H	910	S	Dcsc/sssh
518	4105-7618	R. Samsel	do.	1977	H	925	S	Dcsc/sssh
519	4105-7618	Eldon Benjamin	do.	1968	H	1,025	S	Dcsc/sssh
520	4104-7621	John Babich	---	1968	H	825	W	Dtr/sssh
521	4058-7629	A and S Auto Body	Stackhouse	1979	H	495	V	Dmr/sh
522	4100-7614	Michael Bobraski	R. R. Hornberger	1977	H	925	W	Dcsc/sssh
523	4101-7615	Gary Frace	Champion	1970	H	870	H	Dciv/sssh

(CONTINUED)

Total depth below land surface (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Depth(s) to water-bearing zone(s) (feet)	Static water level: Depth below land surface (feet)	Static water level: Date measured (mo/yr)	Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/pumping rate (gal/min)	Pumping period (hours)	Hardness (mg/L)	Specific conductance (µmho/cm at 25°C)	Well number
100	70	6	76	---	---	6	---	---	34	93	Co-421
150	20	6	110;135	---	---	8	---	---	17	19	422
---	---	---	---	32	6/81	---	---	---	17	20	423
185	60	6	140;175	113	6/81	10	---	---	17	41	424
100	40	6	85	---	---	8	---	---	17	47	425
100	20	6	80	10	1/79	12	---	---	34	78	426
125	20	6	115	26	6/81	8	---	---	68	158	427
125	40	6	95	---	---	8	---	---	34	74	428
90	20	6	60	40	1/77	5	---	---	---	---	429
100	20	6	80	---	---	10	---	---	---	---	430
100	30	6	84	30	8/72	7	---	---	---	---	431
175	20	6	140	---	---	5	---	---	---	---	432
100	20	6	74	---	---	6	---	---	---	---	433
125	40	6	104	55	6/81	7	---	---	17	47	434
150	40	6	60;120	---	---	12	---	---	---	---	435
90	---	---	---	15	8/81	---	.12/4	3	103	278	436
145	90	6	---	29	7/81	---	.64/3	1	51	112	437
175	60	6	80;162	80	7/72	16	---	---	34	87	438
175	100	6	155	---	---	10	---	---	---	---	439
---	---	---	---	---	---	---	---	---	34	150	440
---	---	---	---	19	4/82	---	---	---	291	580	441
---	---	---	---	19	4/82	---	---	---	---	---	443
---	---	---	---	14	4/82	---	---	---	---	---	446
155	32	8	142;152	26	8/81	150	2.2/200	28	395	750	448
500	54	7	110;171;330; 361;410	28	5/81	60	.84/34	1	137	335	452
---	---	---	---	25	7/81	---	---	---	120	255	453
---	---	---	---	63	7/81	---	---	---	34	70	454
---	---	---	---	---	---	---	---	---	---	234	455
220	62	6	---	120	6/79	24	---	---	---	---	456
---	---	---	---	101	7/81	---	2.7/9	1	171	290	457
170	29	6	92	54	7/79	---	---	---	---	213	458
190	39	6	130	114	7/81	---	1.7/11	1	137	275	459
125	26	6	26	9	7/81	15	.36/3	1	86	200	460
200	29	---	86;96;125;170	77	7/81	12	.05/2	2	---	920	461
---	---	---	---	---	---	---	---	---	---	---	462
---	---	---	---	---	---	---	---	---	---	---	463
85	24	6	80	45	12/66	30	---	---	17	60	464
125	30	6	90;105	40	4/76	22	---	---	34	97	465
100	20	6	75	---	---	6	---	---	34	108	466
106	---	---	78;93	30	6/81	---	.13/5	1	120	300	467
90	---	---	---	33	7/81	---	.05/3	1	120	330	468
105	60	6	90	65	9/72	8	---	---	---	---	469
100	80	6	85	---	---	8	---	---	---	---	470
80	65	6	72	7	6/66	50	3.9/---	---	---	---	471
165	40	6	80;155	---	---	10	---	---	---	---	472
---	---	---	---	27	8/81	---	---	---	17	34	473
125	42	6	96	---	---	8	---	---	---	---	474
100	35	6	65	23	8/81	7	---	---	---	---	501
250	---	---	---	111	8/81	---	.34/25	8	---	---	502
125	60	6	100	84	8/81	6	3.4/9	1	34	50	503
36	---	---	---	15	11/81	---	2.4/20	1	34	67	504
570	40	8	112;275;460; 550	15	9/81	360	2.0/280	24	154	300	505
---	30	6	---	113	8/81	---	.08/3	1	34	70	506
125	40	6	95	74	8/81	6	---	---	---	---	507
120	25	6	105	---	---	8	---	---	---	---	508
135	36	6	118	40	7/72	10	---	---	34	84	509
200	40	6	80	---	---	5	---	---	34	60	510
150	80	6	120	---	---	8	---	---	---	---	511
100	35	6	78	---	---	8	---	---	---	---	512
125	42	6	103	---	---	6	---	---	---	---	513
125	20	6	98	48	8/72	7	---	---	---	---	514
323	---	---	---	---	---	3	---	---	86	205	515
75	42	6	63	5	11/72	8	---	---	---	---	516
150	40	6	95;120	---	---	8	---	---	---	---	517
150	80	6	130	---	---	10	---	---	17	47	518
150	70	6	130	29	8/81	10	---	---	---	---	519
85	20	6	39;71;80	15	4/68	5	.07/---	---	51	180	520
123	41	6	112	5	9/81	---	---	---	68	350	521
135	23	6	55;127	60	3/77	10	---	---	---	185	522
150	40	6	75;150	---	---	6	---	---	51	153	523

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Co-524	4101-7615	Glen Whitmore	Champion	1970	H	830	H	Dciv/sssh
525	4101-7616	James Hyde	do.	1974	H	865	S	Dtr/sssh
526	4106-7621	Twin Bridges County Park	Wieand Brothers	1976	P	625	T	Qgo/sg
527	4106-7621	Ruth Sterner	---	1967	H	625	T	Qgo/sg
528	4105-7619	David McMurtrie	Champion	1973	H	900	S	Dcsc/sssh
555	4100-7614	Mike Grant	---	1981	H	925	H	Dcsc/sssh
556	4100-7614	Kenneth Haskell	Champion	1969	H	870	W	Dcsc/sssh
557	4100-7615	Gordon Derr	do.	1970	H	902	S	Dciv/sssh
558	4101-7618	Charmaine Keefer	Clifton Buck	1968	H	510	T	Dmh/sh
559	4104-7619	Edward Ruckel	---	1976	H	875	W	Dcsc/sssh
560	4104-7619	John Rakich	Champion	1973	H	960	S	Dciv/sssh
561	4104-7619	Charles Wike	do.	1976	H	960	S	Dciv/sssh
562	4058-7625	Hitoshi Sato	Ronald Randler	1981	H	880	H	Dtr/sssh
563	4104-7620	Rodney Grasley	Champion	1973	H	685	V	Dtr/sssh
564	4103-7619	Gerald Wolfe	Clifton Buck	1968	H	600	S	Dmh/sh
565	4105-7621	Lester Dietterick	Champion	1978	H	1,000	S	Dcsc/sssh
566	4105-7616	Ronald Davis	do.	1974	H	1,055	H	Dciv/sssh
567	4104-7621	William Correll	Stackhouse	1981	H	780	W	Dciv/sssh
568	4058-7631	William Berger	Clifton Buck	1968	H	595	S	Dmr/sh
569	4102-7622	Evelyn Stauffer	Stackhouse	1973	H	730	H	Sb/sh
570	4101-7625	Harold Buch	---	1979	H	770	S	Smk/sls
571	4059-7627	ARCO	Wieand Brothers	1980	O	480	T	Swc/dls
572	4059-7627	do.	do.	1980	O	480	T	Swc/dls
573	4059-7627	do.	do.	1980	O	480	T	Swc/dls
574	4100-7631	R. Snyder	---	1973	H	625	S	Dmh/sh
575	4059-7630	Benard George	Alvin Swank and Son	1972	H	1,000	W	Srl/sls
576	4059-7631	William McGinley	do.	1977	H	900	W	Srl/sls
577	4059-7632	Ben Mourey	R. R. Hornberger	1969	H	825	W	Sru/sls
578	4059-7633	Kenneth Girton	do.	1974	H	790	W	Sru/sls
584	4055-7627	Rohrbach Farms	Roy Zimmerman	1968	H	965	H	Dcsc/sssh
585	4104-7631	R. Faust	---	1974	H	970	S	Dciv/sssh
586	4101-7625	Scerbo Medical Center	Stackhouse	1981	H	685	H	Smk/sls
								LUZERNE
Lu-368	4104-7609	Beach Haven Fire	Champion	1973	C	540	S	Dmh/sh
369	4105-7612	Virgil Rhinard	R. R. Hornberger	1966	H	1,010	S	Dciv/sssh
370	4105-7611	Arthur Varner	Champion	1974	H	820	S	Dh/sh
371	4105-7610	Herb Brader	do.	1972	H	840	S	Dh/sh
372	4105-7611	Bill Weadon	do.	1974	H	810	S	Dmh/sh
373	4104-7611	Nebbie DiAugstine	do.	1974	H	640	S	Dmr/sh
375	4106-7612	Bart Gunther	R. R. Hornberger	1967	H	1,020	W	Dcsc/sssh
376	4105-7613	Harold Kessler	Champion	1973	H	910	W	Dtr/sssh
377	4105-7612	Larue Bogart	do.	1976	H	880	W	Dtr/sssh
378	4106-7612	Earl Keller	do.	1973	H	1,010	S	Dciv/sssh
380	4102-7609	Larry Kline	---	1974	H	880	W	Dtr/sssh
381	4102-7610	do.	Champion	1974	H	940	W	Dciv/sssh
382	4102-7610	Donald Steinhaver	---	1974	H	910	W	Dciv/sssh
383	4102-7610	Whitmire	Champion	1974	H	900	W	Dciv/sssh
384	4102-7610	Tom Aten	do.	1974	H	875	W	Dciv/sssh
385	4102-7608	Roland Deischaine	do.	1974	H	960	W	Dcsc/sssh
417	4103-7613	Pennsylvania Department of Transportation	---	1977	U	480	C	Dmr/sh
418	4103-7613	do.	---	1977	U	486	C	Dmr/sh
419	4104-7608	Salem Township	Champion	1970	H	580	S	Dmh/sh
420	4105-7608	Michail Mont	do.	1972	H	560	S	Dmh/sh
421	4104-7610	Steven Zwolinski	Clifton Buck	1968	H	540	S	Dmh/sh
422	4104-7610	Gene Kmetovicz	do.	1967	H	570	S	Dmh/sh
423	4104-7610	Wellington Davenport	---	---	H	515	V	Dmh/sh
424	4104-7610	Gene Killian	Clifton Buck	1967	H	535	S	Dmh/sh
425	4104-7610	Steve Molnor	Champion	1976	H	560	S	Dmh/sh
426	4104-7609	Robert Price	R. R. Hornberger	1967	H	645	T	Dmh/sh
427	4104-7609	George Griffin	Reichard	1957	H	645	T	Dmh/sh
428	4104-7609	Robert Price	R. R. Hornberger	1973	H	560	S	Dmh/sh
429	4106-7608	Fred Hummel	Champion	1976	P	540	T	Dtr/sssh
430	4104-7608	Clarence Fox	---	1946	H	500	V	Dmh/sh
431	4104-7613	Bennie Naunczek	Champion	1977	H	640	S	Dmh/sh
432	4104-7613	do.	do.	1976	C	640	S	Dmh/sh
433	4104-7613	Robert Pinterich	do.	1976	H	640	S	Dmr/sh
434	4104-7609	William Davis	do.	1973	H	525	V	Dmh/sh
436	4104-7609	Russel Burke	do.	1973	H	560	S	Dmh/sh
437	4104-7610	Sheldon Molyneaux	do.	1974	H	538	S	Dmh/sh
438	4104-7611	Watts	Virgil Buck	1980	H	740	H	Dmr/sh
439	4105-7608	Pennsylvania Power and Light Co.	---	1970	U	820	S	Dmh/sh
440	4105-7608	do.	---	1970	U	722	S	Dmh/sh
441	4105-7608	do.	---	1970	U	677	T	Qgo/sg
442	4105-7608	do.	---	1970	U	661	T	Dmh/sh

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (μmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
90	40	6	70	---	---	10	---	---	34	95	Co-524
175	20	6	145	64	9/81	6	---	---	51	111	525
50	47	8	---	7	9/81	60	---	---	---	---	526
28	31	6	---	10	7/67	20	---	---	---	---	527
200	35	6	115;173	---	---	8	---	---	---	---	528
300	---	---	---	67	9/81	---	---	---	---	---	555
75	40	6	65	---	---	30	---	---	---	---	556
150	40	6	90;130	---	---	20	---	---	17	53	557
55	56	6	52	19	7/68	20	.65/---	---	68	225	558
275	33	6	150;250	---	---	8	---	---	---	---	559
200	40	6	160	---	---	10	---	---	---	---	560
200	45	6	176	---	---	6	---	---	---	---	561
151	28	6	70	46	10/81	20	.14/9	4	68	160	562
75	20	6	55	4	9/81	6	---	---	51	115	563
40	20	6	38	---	9/81	10	.30/---	---	120	120	564
80	80	6	---	35	11/81	20	3.8/17	1	17	26	565
175	20	6	70;160	---	---	8	---	---	---	---	566
98	---	---	---	7	11/81	20	.34/12	2	51	148	567
81	57	6	62;78	20	10/68	16	2.0/---	---	---	---	568
120	20	6	---	---	---	16	---	---	68	137	569
300	20	6	---	109	12/81	20	---	---	103	158	570
68	68	10	---	18	9/80	---	11/175	5	---	---	571
30	30	6	---	20	9/80	---	3.1/10	5	---	---	572
30	30	10	---	14	4/82	---	---	---	---	---	573
147	30	6	---	26	12/78	---	---	---	---	---	574
175	40	6	---	---	---	19	---	---	---	---	575
125	42	6	---	29	10/78	---	---	---	---	---	576
190	90	6	---	---	---	---	---	---	---	---	577
115	80	6	---	---	---	---	---	---	---	---	578
235	64	6	81;120;230	---	---	18	---	---	68	225	584
---	---	---	---	---	---	---	---	---	34	86	585
198	---	---	---	---	---	15	---	---	103	220	586
COUNTY											
100	25	6	70	40	4/73	12	---	---	128	255	Lu-368
95	40	6	55;85	25	10/66	9	.14/---	---	85	111	369
125	113	6	120	---	---	7	---	---	---	---	370
100	68	6	75	34	12/80	12	---	---	---	---	371
125	40	6	98	38	12/80	6	---	---	---	---	372
275	30	6	60;240	---	---	4	---	---	103	210	373
215	21	6	119;210	80	9/67	3	.26/---	---	---	---	375
300	35	6	180;215	---	---	5	---	---	---	---	376
125	20	6	86	---	---	7	---	---	---	---	377
125	80	6	105	---	---	8	---	---	---	---	378
140	42	6	80;130	---	---	---	---	---	---	---	380
140	20	6	85;135	---	---	15	---	---	---	---	381
170	42	6	125;165	35	4/74	25	---	---	85	220	382
175	20	6	130;155	---	---	6	---	---	---	---	383
125	40	6	95	---	---	8	---	---	34	125	384
275	21	6	140;270	---	---	---	---	---	---	---	385
16	---	---	---	---	---	---	---	---	---	---	417
49	---	---	---	---	---	---	---	---	---	---	418
175	20	6	155	---	---	12	---	---	171	295	419
100	20	6	76	5	7/80	6	---	---	171	230	420
145	20	6	---	36	8/68	20	1.4/---	---	171	300	421
85	21	6	64;82	22	12/67	14	.35/---	---	103	120	422
---	---	---	---	11	7/80	---	.32/2	1	120	220	423
100	29	6	57;92	---	---	20	.41/---	---	171	340	424
150	20	6	132	---	---	6	---	---	171	345	425
160	109	6	120;155	63	10/80	20	.31/---	---	86	200	426
98	---	---	---	62	7/80	---	---	---	86	220	427
125	62	6	---	48	8/73	---	---	---	68	190	428
90	80	6	87	---	---	10	---	---	---	---	429
55	16	6	---	---	---	---	---	---	154	310	430
125	20	6	120	25	7/80	15	---	---	---	---	431
100	20	6	72	14	7/80	10	---	---	120	255	432
175	20	6	140	35	7/80	5	---	---	154	335	433
100	20	6	80	7	7/80	6	.08/5	1	137	295	434
100	20	6	85	---	---	8	---	---	154	410	436
50	20	6	35	2	7/80	15	---	---	137	340	437
230	21	6	85;220	71	8/70	15	.10/2	1	137	300	438
445	---	---	---	---	---	---	---	---	---	---	439
74	---	---	---	---	---	---	---	---	---	---	440
231	117	6	---	65	12/70	---	---	---	---	---	441
198	68	6	---	54	12/70	---	---	---	---	---	442

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Lu-443	4105-7608	Pennsylvania Power and Light Co.	---	1970	U	657	S	Dmh/sh
444	4105-7608	do.	---	1970	U	643	S	Dmh/sh
445	4105-7608	do.	---	1970	U	663	S	Dmh/sh
446	4105-7608	do.	---	1970	U	642	S	Qal/sg
447	4105-7608	do.	---	1970	U	640	S	Dmh/sh
448	4105-7608	do.	---	1970	U	683	S	Dmh/sh
449	4105-7608	do.	---	1970	U	663	T	Qgo/sg
450	4105-7608	do.	---	1970	U	607	T	Qgo/sg
451	4105-7611	Samuel Knorr	Clifton Buck	1967	H	860	S	Dtr/sssh
452	4104-7609	U.S. Geological Survey	Alvin Swank and Son	1980	O	645	T	Qgo/sg
453	4104-7609	do.	---	1980	O	550	S	Dmh/sh
454	4103-7611	do.	Alvin Swank and Son	1980	O	530	T	Dmh/sh
455	4103-7611	do.	do.	1980	O	530	T	Qgo/sg
456	4104-7609	Brad Smith	do.	1980	H	580	T	Dmh/sh
457	4101-7613	John Robbins	Champion	1976	H	510	V	Dtr/sssh
458	4104-7608	Malvern Wolfe	do.	1970	H	500	T	Dh/sh
459	4202-7609	Hoyt Readler	R. R. Hornberger	1967	H	975	S	Dciv/sssh
460	4203-7612	Robert Selic	Champion	1975	H	580	T	Dmh/sh
461	4105-7611	Wilson Vandermark	R. R. Hornberger	1959	H	945	S	Dtr/sssh
462	4105-7611	Gerald Karchner	do.	1967	H	835	S	Dh/sh
463	4105-7612	Richard Bognar	---	1976	H	880	S	Dtr/sssh
464	4105-7611	Debra Golomb	Champion	1970	H	700	W	Dmh/sh
465	4104-7613	Bennie Naunczek	do.	1971	H	780	S	Dmh/sh
466	4104-7613	Larry Feissnor	do.	1973	H	760	S	Dmh/sh
468	4103-7612	William Seigfred	---	1976	H	500	T	Dmr/sh
469	4103-7612	Walter Ryman	---	1980	S	590	H	Dmh/sh
471	4103-7609	Rudy Felix	---	---	H	500	T	Dmh/sh
472	4105-7608	Pennsylvania Power and Light Co.	---	1970	U	649	S	Dmh/sh
473	4105-7608	do.	---	1970	U	702	S	Dmh/sh
474	4105-7608	do.	---	1970	U	667	S	Dmh/sh
475	4105-7608	do.	---	1970	U	680	S	Dmh/sh
476	4105-7608	do.	---	1970	U	683	S	Dmh/sh
477	4105-7608	do.	---	1970	U	646	W	Dmh/sh
478	4105-7608	do.	---	1970	U	667	S	Dmh/sh
479	4105-7608	do.	---	1970	U	704	S	Dmh/sh
481	4105-7609	William Sink	---	---	H	675	T	Dmh/sh
482	4103-7611	William Zettle	---	1958	H	615	T	Dmh/sh
483	4106-7607	Pennsylvania Power and Light Co.	---	1973	U	505	T	Dtr/sssh
484	4105-7607	do.	---	1973	U	505	T	Qgo/sg
485	4105-7607	do.	---	---	U	505	T	Qgo/sg
486	4105-7607	do.	---	1973	N	501	T	Qgo/sg
487	4105-7607	do.	---	1972	N	505	T	Qgo/sg
488	4105-7607	do.	---	1972	U	505	T	Qgo/sg
489	4105-7608	do.	---	1972	U	505	T	Qgo/sg
490	4105-7608	do.	---	1973	N	615	T	Qgo/sg
491	4105-7608	do.	---	1973	N	620	T	Qgo/sg
492	4106-7610	John Krisanda	Champion	1975	H	940	S	Dtr/sssh
493	4106-7610	Lemuel Sitler	do.	1973	H	885	W	Dciv/sssh
494	4106-7610	George Honse	do.	1975	H	805	W	Dciv/sssh
495	4106-7610	Frank Peters	do.	1976	H	930	S	Dciv/sssh
496	4106-7610	do.	do.	1972	H	940	S	Dciv/sssh
497	4106-7609	Russel Baer	do.	1981	H	880	S	Dciv/sssh
498	4106-7610	Thomas Holloway	do.	1974	H	960	S	Dcsc/sssh
499	4106-7611	Frank Bloom	do.	1976	H	1,040	S	Dcsc/sssh
500	4101-7610	Harold Seward	---	1976	H	922	S	Dcsc/sssh
501	4102-7610	Mark Adams	---	1974	H	910	H	Dciv/sssh
502	4101-7611	Callahan	Champion	1974	H	930	H	Dcsc/sssh
503	4102-7611	Orville Benjamin	---	1974	H	903	S	Dtr/sssh
504	4105-7613	Harry Bombushime	Champion	1973	H	1,040	H	Dtr/sssh
505	4105-7613	Donald McCoy	do.	1974	H	960	W	Dtr/sssh
506	4105-7613	Michael Kennedy	do.	1974	H	1,000	W	Dtr/sssh
507	4100-7608	Charles Jurewicz	---	1974	H	990	H	Mmc/sssh
508	4101-7612	David Fuller	---	1974	H	865	S	Dcsc/sssh
509	4106-7612	Jim Switzer	Champion	1972	H	1,015	S	Dciv/sssh
510	4101-7612	Wilton Shiner	Roy Zimmerman	1967	H	842	W	Dcsc/sssh
512	4107-7609	Robert Boston	Champion	1973	H	878	S	Dcsc/sssh
513	4107-7610	William Crisbell	do.	1972	U	885	S	Dcsc/sssh
514	4106-7610	Nick Dalberto	do.	1976	U	1,030	W	Dciv/sssh
515	4106-7610	Paul Reichard	do.	1973	H	950	W	Dciv/sssh
516	4104-7610	Beach Haven Community Board	---	1968	H	510	V	Dmh/sh
517	4106-7608	Pennsylvania Power and Light Co.	Champion	1977	H	520	T	Dtr/sssh

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hardness (mg/L)	Specific conductance (μmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
110	9	6	---	17	9/70	---	---	---	---	---	Lu-443
227	47	6	---	32	12/70	---	---	---	---	---	444
144	---	---	---	21	12/70	---	---	---	---	---	445
168	38	---	---	29	12/70	---	---	---	---	---	446
263	42	---	---	35	12/70	---	---	---	---	---	447
117	17	---	---	29	12/70	---	---	---	---	---	448
208	101	---	---	62	12/70	---	---	---	---	---	449
176	95	2	---	14	12/70	---	---	---	---	---	450
117	52	6	113	32	8/80	8	.09/---	---	34	75	451
---	100	6	---	62	10/80	20	84/60	1	---	237	452
300	56	6	92;145;220	51	10/80	5	.05/4	2	68	233	453
200	56	6	75;130	22	12/80	6	.13/10	3	103	138	454
55	55	6	---	20	12/80	30	12/36	4	34	82	455
130	50	6	---	36	10/80	---	---	---	86	135	456
35	30	6	33	12	---	12	---	---	---	---	457
175	45	6	120;135	---	---	5	---	---	---	---	458
---	55	6	110	---	---	15	---	---	---	---	459
---	---	---	145	---	---	10	---	---	86	142	460
90	---	---	---	64	12/80	---	---	---	---	---	461
130	110	6	120	25	11/67	10	.10/---	---	---	---	462
200	23	6	140;195	60	6/76	25	---	---	---	---	463
125	30	6	90	8	12/80	---	---	---	---	---	464
100	20	6	70;95	30	8/71	12	---	---	---	---	465
175	30	6	155	100	3/73	10	---	---	---	---	466
85	---	---	40;70	5	6/76	25	---	---	---	---	468
340	132	6	---	81	12/80	35	---	---	---	---	469
470	48	6	340	22	12/80	---	.03/2	1	---	4450	471
---	20	6	---	31	12/70	---	---	---	---	---	472
---	11	6	---	34	12/70	---	---	---	---	---	473
---	45	1	---	27	12/70	---	---	---	---	---	474
---	---	---	---	28	12/70	---	---	---	---	---	475
---	---	---	---	18	10/70	---	---	---	---	---	476
---	25	1	---	5	12/70	---	---	---	---	---	477
---	---	---	---	26	12/70	---	---	---	---	---	478
---	---	---	---	6	12/70	---	---	---	---	---	479
50	---	---	---	4	4/81	---	---	---	---	---	481
196	---	---	---	93	4/81	---	---	---	---	---	482
54	52	8	---	16	1/73	---	---	---	---	---	483
91	91	8	---	---	---	---	---	---	---	---	484
44	44	2	---	12	5/81	---	---	---	---	---	485
58	58	12	---	7	5/81	---	16/495	54	54	180	486
75	75	3	---	24	8/72	---	27/9	1	70	200	487
55	---	---	---	---	---	---	---	---	---	---	488
23	---	---	---	---	---	---	---	---	---	---	489
---	---	---	---	9	12/73	---	1.6/65	7	49	142	490
---	---	---	---	17	11/73	---	7.0/150	9	46	136	491
100	20	6	45;80	---	---	6	---	---	---	---	492
100	20	6	76	---	---	12	---	---	34	102	493
150	20	6	85	---	---	5	---	---	---	---	494
150	20	6	130	---	---	6	---	---	34	88	495
130	20	6	110	10	11/72	8	---	---	34	94	496
125	25	6	112	---	---	10	---	---	---	---	497
125	32	6	95	---	---	6	---	---	---	---	498
150	60	6	103	---	---	8	---	---	---	---	499
245	37	6	80;220	50	2/76	22	---	---	---	---	500
230	32	6	140;215	30	3/74	18	---	---	---	---	501
300	20	6	230	160	4/74	2	---	---	---	---	502
125	32	6	65;110	20	7/74	---	---	---	---	---	503
300	20	6	180;205	---	---	6	---	---	---	---	504
250	20	6	190	---	---	6	---	---	---	---	505
250	20	6	210	---	---	7	---	---	---	---	506
200	21	6	105;180	50	8/74	20	---	---	---	---	507
185	24	6	125;160	40	3/74	20	---	---	51	140	508
75	30	6	60	35	11/72	6	---	---	34	---	509
112	30	6	81;107	---	---	3	---	---	---	---	510
175	70	6	153	---	---	6	---	---	102	200	512
110	20	6	93	35	11/72	10	---	---	---	---	513
150	20	6	120	---	---	6	---	---	---	---	514
125	35	6	104	45	1/73	6	---	---	---	---	515
51	21	6	42;47	12	10/68	40	---	---	---	---	516
100	62	6	73	24	8/80	---	.43/15	8	---	140	517

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
								MONTOUR
Mt- 1	4058-7634	Mahoning Township Authority	Moody and Associates	1969	P	610	V	Sto/lsd
2	4058-7634	do.	do.	1969	P	610	V	DSk/ls
3	4058-7634	do.	Wieand Brothers	1978	P	610	V	DSk/ls
4	4058-7634	do.	do.	1978	P	610	V	DSk/ls
5	4058-7635	do.	R. R. Hornberger	1966	P	790	W	Sru/sls
6	4058-7635	do.	do.	1960	P	790	W	Sru/sls
7	4058-7635	do.	do.	1960	P	850	S	Srm/sls
8	4058-7635	do.	do.	1960	P	850	S	Srm/sls
9	4057-7634	Maria Joseph Manor	do.	1960	T	535	V	Dmh/sh
10	4057-7634	do.	do.	1961	T	535	V	Dmh/sh
11	4057-7634	do.	do.	---	T	540	V	Dmh/sh
12	4057-7634	do.	---	1965	T	535	V	Dmh/sh
14	4059-7638	Red Roof Inn	Wieand Brothers	1973	C	500	V	DSk/ls
15	4059-7638	do.	do.	1973	C	500	V	Sto/lsd
16	4059-7638	Sheraton Inn	do.	1978	C	505	V	Do/lss
17	4059-7638	do.	do.	1973	C	505	V	Don/lss
18	4059-7638	Holiday Inn	---	1967	C	515	V	Do/lss
19	4058-7636	Geisinger Medical Center	R. R. Hornberger	1961	T	560	W	Smk/sls
20	4058-7636	do.	---	1961	T	560	W	Smk/sls
21	4058-7636	do.	---	1965	T	560	W	Smk/sls
22	4058-7634	Frosty Valley Country Club	R. R. Hornberger	1966	I	640	W	Swc/dls
23	4058-7633	C. Seitz	Ronald Randler	1978	H	660	S	DSk/ls
24	4059-7637	Sunnybrook Park	do.	1978	H	490	V	Sru/sls
25	4057-7636	TRW, Inc.	R. R. Hornberger	1975	N	467	T	DSk/ls
26	4057-7636	do.	do.	---	---	467	T	Sto/lsd
27	4057-7636	Roselon Yarns, Inc.	do.	1967	N	470	T	Swc/dls
29	4058-7634	Charles Keiter	Wieand Brothers	1979	P	895	W	Srl/sls
30	4059-7638	Holiday Inn	do.	1973	C	520	V	Dmr/sh
31	4059-7638	do.	do.	1972	C	515	V	DSk/ls
32	4059-7638	do.	do.	1973	C	515	V	Do/lss
33	4059-7637	David Shoemaker	R. R. Hornberger	1975	H	580	S	Swc/dls
34	4058-7644	Steve Rine	Wieand Brothers	1975	H	670	H	DSk/ls
35	4057-7632	Brown Catering	R. R. Hornberger	1968	C	900	W	Dtr/sssh
36	4058-7641	Mitchell Duffy	do.	1976	H	955	H	Srl/sls
37	4058-7642	Eugene Appleman	Wieand Brothers	1972	H	620	S	Dmr/sh
38	4059-7642	Robert Foust	Ronald Randler	1976	H	660	S	Dmh/sh
39	4059-7642	Earnest Bower	R. R. Hornberger	1967	H	638	W	Dmh/sh
40	4059-7641	Robert Reedy	Ronald Randler	1967	H	620	W	Dtr/sssh
41	4059-7641	Paul Appleman	R. R. Hornberger	1975	H	590	W	Dmh/sh
42	4058-7643	Donald Golder	do.	1968	H	630	S	Dmh/sh
43	4058-7642	George Buckley	Ronald Randler	1967	H	590	S	Dmh/sh
44	4059-7642	P. Kohl	do.	1967	H	650	S	Dmh/sh
45	4059-7641	Arthur Reedy	R. R. Hornberger	1966	H	630	S	Dmh/sh
46	4058-7633	Pennsylvania Society for Prevention of Cruelty to Animals	do.	1968	H	645	S	Sto/lsd
47	4058-7633	Chester Adams	do.	1967	H	660	S	DSk/ls
48	4058-7632	Robert Fry	do.	1975	H	670	S	Do/lss
49	4058-7632	Stuart Hartman	Ronald Randler	1974	H	690	S	DSk/ls
50	4058-7632	Clewell Vending	do.	1967	H	630	V	Dmr/sh
51	4058-7632	William Linker	Wieand Brothers	1975	H	670	S	Dmh/sh
52	4058-7634	Harry Stamey	R. R. Hornberger	1973	H	750	S	Sb/sh
53	4058-7634	D. Schuller	do.	1974	H	650	S	Swc/dls
54	4058-7634	Harold Henry	do.	1968	H	730	S	Sb/sh
55	4058-7634	Harvey Houseknect	do.	1977	H	630	S	Sto/lsd
56	4058-7634	Robert Albertini	do.	1975	H	715	S	Sb/sh
57	4058-7639	Paul Earlston	Ronald Randler	1973	H	900	S	Srl/sls
58	4058-7639	George Lewellyn	R. R. Hornberger	1967	H	780	W	Srl/sls
59	4101-7638	Randall Billmeyer	Wieand Brothers	1977	H	880	H	Dtr/sssh
60	4100-7642	Peter Cooper	do.	1977	H	600	S	Dh/sh
61	4100-7642	R. Hedding	Ronald Randler	1978	H	720	S	Dh/sh
62	4100-7642	James Dunkle	do.	1969	H	730	S	Dmh/sh
63	4101-7640	William Starr	do.	1977	H	740	S	Dtr/sssh
64	4100-7643	Henry Schmidt	do.	1978	H	520	V	Dmr/sh
65	4101-7642	M. Stahl	Wieand Brothers	1979	H	530	S	Do/lss
66	4101-7643	Kenneth Permar	R. R. Hornberger	1967	H	580	S	Do/lss
67	4102-7641	Rick Burkhart	Ronald Randler	1977	H	540	S	Do/lss
68	4102-7641	John Tanner	R. R. Hornberger	1970	H	580	S	Don/lss
69	4101-7643	Ralph Swartz	Ronald Randler	1976	H	525	S	Do/lss
70	4101-7638	William McMichael	R. R. Hornberger	1966	H	635	W	Dtr/sssh

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
COUNTY											
332	114	8	122	47	8/69	50	.70/50	12	205	370	Mt- 1
328	92	8	99;191;241	46	8/69	300	7.7/200	72	---	416	2
298	42	6	99;277	---	---	15	---	---	---	---	3
298	112	10	---	116	11/78	---	3.8/200	48	---	---	4
305	59	7	95;130;198; 287;290;302	---	1/66	300	1.1/75	72	---	---	5
312	43	6	60;207;245; 258;275;312	---	9/60	125	1.4/50	---	---	---	6
---	---	---	---	---	---	10	---	---	---	---	7
---	---	---	---	---	---	10	---	---	---	---	8
610	35	8	210;350;430	---	---	62	---	---	---	---	9
257	45	7	---	---	---	50	---	---	---	---	10
210	---	---	---	---	---	50	---	---	---	---	11
350	---	---	---	7	11/80	10	---	---	---	---	12
205	65	8	---	19	4/74	200	41/330	24	---	---	14
259	70	8	---	15	4/74	80	1.1/73	24	---	---	15
309	45	8	51;88;210; 237;239;285	15	10/73	600	5.3/158	24	---	---	16
95	36	8	40;50;65; 70;80	15	10/73	125	2.7/122	24	---	---	17
---	---	---	---	5	9/67	---	.67/80	8	---	---	18
300	34	7	---	---	---	60	---	---	---	---	19
400	34	7	---	---	---	60	---	---	---	---	20
314	63	7	---	---	---	190	---	---	---	---	21
213	22	8	45;183;207	F	7/66	100	2.5/---	---	---	---	22
213	119	6	175;210	96	7/78	30	.88/---	---	---	---	23
93	21	6	90	5	8/78	30	.67/---	---	---	---	24
200	109	10	---	23	4/75	450	19/500	24	---	---	25
100	---	6	---	28	---	---	38/85	8	---	---	26
308	73	10	150;185;230; 280	30	6/67	---	18/380	24	---	---	27
300	42	8	175;257	-69	7/80	200	.80/103	---	120	240	29
438	36	8	82;130;280	---	---	10	.07/20	24	---	---	30
505	31	8	290	F	6/80	900	9.0/207	60	---	1,000	31
218	35	8	45;80;95; 130;155	12	1/74	80	.47/73	24	---	---	32
215	63	6	140;203	68	10/78	4	---	---	---	---	33
223	93	6	202	---	---	25	---	---	---	---	34
390	40	7	84;140;256; 315;369;384	115	5/68	60	.22/60	---	---	---	35
215	20	6	140;195	80	11/78	2	---	---	120	239	36
127	20	6	50;70;85	---	---	15	---	---	---	---	37
40	27	5	40	15	6/76	30	3.0/---	---	---	---	38
90	21	6	70;82	20	3/67	5	.07/---	---	---	---	39
223	20	6	200	7	7/67	1	.03/---	---	---	---	40
33	20	6	---	1	11/78	25	---	---	---	---	41
95	5	6	31;60;80	---	---	5	.06/---	---	---	---	42
76	51	6	74	---	---	30	---	---	---	---	43
35	15	6	34	4	11/78	20	1.00/---	---	---	---	44
200	21	6	190	8	7/66	5	.03/---	---	---	---	45
75	57	6	65	35	7/68	40	1.00/---	---	---	---	46
165	21	6	70;118;163	60	8/67	20	.31/---	---	---	---	47
215	41	6	---	41	11/78	2	---	---	---	---	48
169	42	6	165	82	11/78	5	---	---	---	---	49
88	44	6	75;85	---	---	10	.13/---	---	---	---	50
123	20	6	74;86	19	11/78	8	---	---	---	---	51
150	21	6	---	44	8/73	8	---	---	---	---	52
155	42	6	---	20	10/74	8	---	---	---	---	53
215	51	6	102;164;189	50	7/68	12	.07/---	---	---	---	54
185	124	6	170	125	8/77	20	---	---	---	---	55
195	41	6	---	---	---	6	---	---	---	---	56
153	26	5	---	---	---	5	---	---	---	---	57
75	40	6	53;60;64;68	1	6/67	30	.41/---	---	---	---	58
398	21	6	---	125	6/80	1	.03/5	1	---	270	59
98	20	6	42;68	F	6/80	20	.55/9	1	154	368	60
150	31	6	145	26	10/78	4	.03/---	---	---	---	61
122	20	6	90;120	60	9/69	---	---	---	---	---	62
202	27	6	188	48	6/80	3	.03/---	---	---	107	63
93	11	6	80	11	10/78	10	.14/---	---	---	---	64
173	64	6	136;150	28	6/80	20	---	---	---	315	65
95	51	6	65;90;91	30	4/67	50	.77/---	---	---	440	66
83	50	6	80	44	12/77	20	.51/---	---	---	105	67
90	46	6	56;68;86	43	7/70	12	---	---	---	205	68
86	39	6	80	33	6/80	20	.77/---	---	---	165	69
175	20	6	40;75;130	---	12/66	3	.03/---	---	---	---	70

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Mt- 71	41D0-7639	Anna Schenk	Ronald Randler	1967	H	895	S	Dtr/sssh
72	4100-7639	Andras	do.	1966	H	900	S	Dtr/sssh
73	41DD-7639	Roland Reedy	do.	1966	H	900	S	Dtr/sssh
74	4101-7640	Harry Hawkins	do.	1969	H	542	S	Dmr/sh
75	4102-7639	Russell Hendrickson	R. R. Hornberger	1976	H	620	S	Dmr/sh
76	4102-7638	Leon Vandine	do.	1976	H	62D	S	Dmr/sh
77	4100-7639	Edward Barry	Wieand Brothers	1976	H	680	W	Dtr/sssh
78	4100-7640	Ronald Horne	Ronald Randler	1977	H	825	S	Dtr/sssh
79	4102-764D	Village Inn	R. R. Hornberger	1974	C	509	V	Don/lss
80	4103-7640	Oanville Area Jointure Schools	do.	1968	T	565	S	Do/lss
81	4103-7640	Bell Telephone Co.	Champion	1975	H	540	S	Oo/lss
82	4103-7640	Rand Parker	R. R. Hornberger	1966	H	520	S	Do/lss
83	4102-7641	Wayne Leighow	Wieand Brothers	1977	H	530	V	Oo/lss
84	4102-7641	Jesse Kelley	---	---	H	530	V	Oo/lss
85	4102-7640	Marvin Funk	---	1957	H	525	V	Dmr/sh
86	4104-7641	L. Martz	R. R. Hornberger	1968	H	520	V	Oo/lss
87	4103-7642	Jerry Gresh	Wieand Brothers	1977	H	760	S	Sto/lsd
88	4103-7642	Richard Hoffman	do.	1976	H	74D	S	Sto/lsd
89	4104-7642	Dean Hebner	R. R. Hornberger	1976	H	665	S	Do/lss
90	4103-7641	Jay Sitler	Wieand Brothers	1976	H	582	S	OSk/ls
91	4103-7641	Lon Tarr	do.	1977	H	680	S	OSk/ls
92	4104-7640	William McMichael	R. R. Hornberger	1969	H	515	V	Omr/sh
93	4105-7638	Clarence McMichael	do.	1967	H	580	W	Omh/sh
94	41D5-7638	Jimmy Holdren	do.	1966	H	605	S	Dmh/sh
95	4106-7638	Dale Sommers	do.	1968	H	665	S	Omh/sh
96	4107-7638	Karl McWilliams	do.	1966	H	720	S	Dmh/sh
97	4106-7637	Allen Dewald	do.	1967	H	712	S	Dmh/sh
98	4106-7637	Hershey	do.	1966	H	712	S	Dmh/sh
99	4106-7637	McGargle	Clifton Buck	1968	H	680	S	Dmh/sh
100	4106-7637	George Holdren	R. R. Hornberger	1968	H	730	S	Dmh/sh
101	4106-7637	Bryon Sheatler	Virgil Buck	1978	H	660	S	Dmh/sh
102	4103-7639	Richard Baker	Ronald Randler	1966	H	530	V	Dmr/sh
103	4102-7638	Fred Moser	R. R. Hornberger	1967	H	565	V	Dmr/sh
104	4103-7637	Norma Bartlett	Virgil Buck	1972	H	525	S	Dmh/sh
105	4103-7636	Harvey Oavis	R. R. Hornberger	1973	H	640	W	Dmh/sh
106	4103-7637	Wayne Day	do.	1973	H	550	S	Dmh/sh
107	4104-7637	S. Stoltzfus	Ronald Randler	1979	H	535	S	Dmh/sh
108	41D4-7638	Jonas Beiler	do.	1976	H	535	S	Dmr/sh
109	4104-7639	Robert McMichael	R. R. Hornberger	1967	H	545	V	Dmr/sh
110	4104-7638	Sanford Brown	Wieand Brothers	1974	H	565	V	Dmh/sh
112	4106-7643	David Strouse	Ronald Randler	1980	H	610	S	Dmr/sh
113	4106-7643	Mary Hall	do.	1966	H	605	S	Dmr/sh
114	4106-7641	Joseph Davis	Stackhouse	1972	H	575	V	Omr/sh
115	4106-7641	Exchange Grange	Ronald Randler	1967	H	580	V	Omh/sh
116	4106-7641	Warrior Run School	R. R. Hornberger	1966	T	645	S	Dmr/sh
117	4106-7640	Franklin Shupp	Ronald Randler	1967	H	665	H	Omh/sh
118	4106-7641	David Litchard	R. R. Hornberger	1967	H	640	S	Dmh/sh
119	4106-7642	Robert Brouse	Ronald Randler	1968	H	590	S	Dmh/sh
120	4107-7642	Hal Thomas	Wieand Brothers	1976	H	650	S	Dmh/sh
121	4107-7640	Leonard Lyons	Ronald Randler	1969	S	685	S	Dmh/sh
122	4107-7640	James Turri	R. R. Hornberger	1975	H	670	S	Dmh/sh
123	4058-7634	Edward James	Stackhouse	1975	H	940	W	Srl/sls
124	4058-7634	Kenneth Ackerman	Kraemer	1979	H	875	W	Srl/sls
125	4102-7641	Roy Ulrich	R. R. Hornberger	1967	H	560	S	Do/lss
126	4102-7644	O. Fleming	Norman Hagenbuch	1969	H	670	H	Swc/dls
127	4102-7644	James Temple	R. R. Hornberger	1967	H	550	V	Swc/dls
128	4102-7644	Wayne Mincemoyer	Wieand Brothers	1972	H	560	V	Sto/lsd
129	4104-7643	Earl Harris	do.	1976	H	660	S	Sto/lsd
130	41D3-7642	Guy McCollum	R. R. Hornberger	1967	H	7D0	S	Sto/lsd
131	4102-7643	Frank Smith	Wieand Brothers	1977	H	72D	S	OSk/ls
132	4105-7644	Edward Beachel	R. R. Hornberger	1966	H	540	V	Don/lss
133	4106-7642	Ronald Miller	do.	1967	H	565	V	Omh/sh
134	4106-7643	Albert Brown	do.	1967	H	605	S	Omr/sh
135	4100-7643	Ronald Randler	Ronald Randler	1976	H	600	S	Dmh/sh
136	4100-7643	Alicia Bridge	do.	1979	H	620	S	Dmh/sh
137	4100-7643	Richard Smith	do.	1977	H	60D	S	Dmh/sh
138	41D0-7641	Kenneth Burrows	R. R. Hornberger	1972	R	740	S	Dmh/sh
139	4101-7641	Loren Girton	do.	1972	H	660	S	Dmh/sh
140	4101-7643	D. Ale	Wieand Brothers	1978	H	620	S	Do/lss
141	4101-7643	Grace Bankus	Ronald Randler	1968	H	510	V	Do/lss
142	4101-7644	John Styer	R. R. Hornberger	1968	H	580	S	Do/lss
143	4102-7640	James Betz	Ronald Randler	1967	H	520	V	Oo/lss
144	4104-7641	Maynard Lawton	do.	1969	H	525	V	Do/lss
145	4104-7640	Kenneth Bryfogle	Gordon Hill	1980	C	525	V	Do/lss
146	4106-7640	Pennsylvania Power and Light Co.	R. R. Hornberger	1974	R	645	H	Omr/sh
147	4105-7639	do.	do.	1972	R	560	S	Omr/sh
148	4106-7639	do.	do.	1974	R	605	W	Dmh/sh

(CONTINUED)

Total depth below land surface (feet)	Casing Depth (feet)	Casing Diameter (inches)	Depth(s) to water-bearing zone(s) (feet)	Static water level Depth below land surface (feet)	Static water level Date measured (mo/yr)	Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
167	20	6	50;70;165	36	5/67	40	.82/---	---	---	---	Mt- 71
195	27	6	55;135;193	55	6/66	10	.07/---	---	---	---	72
173	31	6	45;125;170	35	6/66	5	.04/---	---	---	---	73
82	20	6	80	1	7/69	6	.07/---	---	---	---	74
110	20	6	55;95	42	6/80	12	---	---	---	265	75
80	20	6	68	1	6/80	15	---	---	---	295	76
398	20	6	65	20	6/80	1	---	---	---	183	77
160	16	6	155	73	6/80	7	.08/---	---	---	162	78
29	23	6	---	5	6/80	12	---	---	170	347	79
215	44	7	85;158;210	60	1/68	30	.19/---	---	---	---	80
150	30	6	75;130	---	---	8	---	---	900	2,400	81
130	25	6	86;115	17	7/66	3	---	---	---	---	82
73	20	6	37	16	6/80	60	---	---	171	328	83
30	---	---	---	---	---	---	---	---	103	388	84
210	---	---	---	15	6/80	---	---	---	68	401	85
60	23	6	29;49;56	2	2/68	50	.86/---	---	---	---	86
298	20	6	255	---	---	10	---	---	---	---	87
298	60	6	248	---	---	---	---	---	188	379	88
155	20	6	60	46	5/76	3	---	---	---	---	89
173	38	6	120;147	---	---	15	---	---	---	---	90
348	250	6	316;330	157	7/80	30	---	---	282	605	91
205	20	6	175;205	7	7/80	3	---	---	120	381	92
415	30	6	45;87;196;296	7	7/80	2	.03/---	---	137	554	93
225	20	6	175;215	5	6/66	1	.03/---	---	---	---	94
304	26	6	117	25	4/68	1	.03/---	---	120	399	95
70	19	6	50;56	20	8/66	30	.67/---	---	103	253	96
130	18	6	100;120	17	7/80	2	.03/---	---	---	---	97
170	36	6	164	25	8/66	20	.14/---	---	---	---	98
257	---	---	210	10	5/68	4	.03/---	---	---	---	99
155	24	6	121;149	6	2/68	5	.03/---	---	---	---	100
155	20	6	30;80;140	20	5/78	4	.03/---	---	---	---	101
84	16	6	25;50;84	16	5/66	6	.09/---	---	---	---	102
50	26	6	46;48	5	6/67	15	.33/---	---	---	---	103
218	20	6	75;210;218	---	---	4	---	---	---	---	104
80	30	6	---	26	2/73	10	---	---	---	---	105
250	21	6	---	10	8/73	1	---	---	34	399	106
180	16	6	180	12	7/80	2	.03/---	---	---	---	107
268	19	6	60;260	14	7/80	1	.03/---	---	---	---	108
81	42	6	63	---	---	4	.06/---	---	---	---	109
346	21	6	236;251	25	7/80	4	---	---	17	460	110
118	---	---	---	---	---	11	---	---	67	---	112
75	22	6	73	15	12/66	7	.12/---	---	---	---	113
70	28	6	68	---	---	12	---	---	---	---	114
35	25	6	33	4	3/67	15	.48/---	---	---	---	115
215	82	7	118;184	60	12/66	15	.10/---	---	---	---	116
122	52	6	85;120	32	6/67	10	.11/---	---	---	---	117
184	---	---	50;105;180	22	11/67	8	.05/---	---	530	1,150	118
80	35	6	45;78	---	---	50	3.3/---	---	---	---	119
248	18	6	203	46	7/80	10	---	---	---	---	120
200	10	6	105	15	5/69	1	.03/---	---	180	448	121
175	20	6	---	10	7/73	3	---	---	---	---	122
150	21	6	---	---	7/80	30	---	---	86	210	123
136	---	---	---	1	7/80	25	---	---	68	120	124
128	26	6	120	2	7/80	40	.41/---	---	120	208	125
300	---	---	165;225;285	150	4/69	20	---	---	---	---	126
33	20	6	25;27	11	5/67	40	1.8/---	---	239	---	127
80	41	6	---	12	7/80	30	---	---	---	---	128
223	63	6	185	93	7/80	20	---	---	154	408	129
195	136	6	170;189	100	5/67	5	.05/---	---	171	367	130
248	63	6	150;198	115	7/80	12	---	---	---	---	131
215	23	6	26;195	6	7/80	3	.03/---	---	---	---	132
51	50	6	50	4	8/67	40	.85/---	---	---	---	133
123	29	6	69	22	9/67	2	.03/---	---	---	---	134
102	8	6	100	36	12/76	---	.15/10	---	---	---	135
77	22	6	75	33	7/79	20	.45/---	---	---	---	136
82	8	6	78	36	7/77	40	4.0/---	---	---	---	137
430	18	6	---	21	7/80	1	---	---	154	325	138
150	20	6	---	---	---	3	---	---	120	300	139
122	84	6	97;101	40	7/78	30	---	---	---	---	140
45	30	6	30;44	7	6/68	40	---	---	---	---	141
160	48	6	69;157	50	3/68	5	.05/---	---	---	---	142
48	43	6	42	20	3/67	20	2.0/---	---	---	---	143
38	31	6	38	5	9/69	6	.18/---	---	---	---	144
150	20	6	---	18	7/80	45	---	---	---	---	145
255	52	6	---	60	7/80	---	.19/30	12	188	442	146
200	41	6	75;90;140;200	7	7/80	23	---	---	137	480	147
150	42	6	---	20	7/80	30	.44/30	12	307	640	148

TABLE 23.

Well location						Alti- tude of land surface (feet)	Topo- graphic setting	Aquifer/ lithology
Number	Lat-Long	Owner	Oriller	Year completed	Use			
Mt-149	4106-7640	Richard Hess	---	1969	H	570	S	Omr/sh
150	4107-7639	Joseph Murray	R. R. Hornberger	1975	H	700	W	Omh/sh
151	4107-7637	Ross McCollum	do.	1977	H	765	H	Dmh/sh
152	4100-7641	Kenneth 8urrows	do.	1968	H	780	S	Otr/sssh
153	4100-7636	Oaniel Wetzel	Alvin Swank and Son	1980	H	550	V	Omh/sh
154	4059-7635	Pinebrook Homes	Stackhouse	1980	H	735	S	Sru/sls
156	4100-7636	Carl Hartman	R. R. Hornberger	1976	H	560	S	Dmh/sh
157	4102-7635	Linda Synder	do.	1967	H	825	V	Otr/sssh
158	4100-7636	Gary Morris	---	1976	H	690	H	Omh/sh
159	4100-7637	Joe Hess	R. R. Hornberger	1975	H	808	S	Otr/sssh
160	4100-7637	do.	do.	1974	H	760	S	Otr/sssh
161	4100-7637	8en Hess	do.	1975	H	810	S	Otr/sssh
162	4100-7637	do.	do.	1977	H	849	H	Otr/sssh
163	4100-7637	do.	Neil Negley	1978	H	852	H	Otr/sssh
164	4102-7635	Clyde Gray	R. R. Hornberger	1977	H	890	S	Ociv/sssh
165	4102-7633	Mike Mausteller	do.	1968	H	1,143	H	Ociv/sssh
166	4104-7637	Oonald Robbins	Ronald Randler	1967	H	549	V	Omh/sh
167	4059-7636	Kocker Lot 3	Virgil Buck	1978	H	540	S	Swc/dls
168	4059-7636	Kocker Lot 4	do.	1978	H	540	S	Swc/dls
169	4059-7636	Kocker Lot 5	do.	1978	H	540	S	Swc/dls
170	4059-7636	Kocker Lot 6	do.	1978	H	540	S	Swc/dls
171	4059-7636	Kocker Lot 7	do.	1978	H	540	S	Swc/dls
172	4059-7636	Kocker Lot 9	do.	1978	H	540	S	Swc/dls
173	4104-7604	Kenneth 8ryfogle	Gordon Hill	1980	C	525	V	Oo/lss
175	4104-7638	Jonas Beiler	Ronald Randler	1976	H	535	S	Dmr/sh
176	4058-7634	Mark Cook	do.	1981	H	1,030	S	Srl/sls
177	4059-7634	L. Santini	---	---	H	1,280	H	Srl/sls
178	4100-7636	Joseph Siats	Wieand 8rothers	1981	H	555	V	Omh/sh
181	4059-7635	Joseph Cady	Stackhouse	1981	H	725	S	Sru/sls
182	4059-7636	Kocker Lot 14	Virgil 8uck	1979	H	540	S	Swc/dls
183	4059-7636	Kocker Lot 9	do.	1979	H	540	S	Swc/dls
184	4059-7636	Kocker Lot 8	do.	1979	H	540	S	Swc/dls
185	4058-7635	Pinebrook Homes	Stackhouse	1981	H	810	S	Sru/sls
186	4057-7632	Keener	do.	1981	H	930	H	Otr/sssh
187	4058-7631	William 8arnes	do.	1981	H	740	S	Otr/sssh
188	4058-7631	do.	R. R. Hornberger	---	H	760	S	Otr/sssh
189	4058-7634	Robert McCaffery	do.	1975	H	650	S	Swc/dls
190	4103-7640	Washingtonville Town Hall	---	1928	U	570	V	Oo/lss
191	4104-7639	Oairyman's Coop Association	---	1928	T	545	V	Omh/sh
194	4058-7636	Geisinger Medical Center	---	1930	T	590	S	Sb/sh
202	4059-7638	Outch Pantry	R. R. Hornberger	1974	C	510	V	Oo/lss
203	4059-7638	do.	do.	1973	C	510	V	Oo/lss
204	4059-7638	Metal Wire Recovery	do.	1967	N	510	V	Swc/dls
205	4059-7638	do.	do.	1966	N	510	V	Swc/dls
206	4059-7639	Howard Johnson's	Kohl Brothers	1973	C	630	V	Omr/sh
207	4059-7639	do.	do.	1973	C	630	V	Omr/sh
208	4058-7638	Wayne Bassett	---	1977	H	905	H	Srl/sls
209	4058-7638	James Connell	Alvin Swank and Son	1978	H	940	S	Srl/sls
210	4059-7643	E. Hildebrand	Ronald Randler	1978	H	685	S	Omh/sh
211	4058-7643	M. Prowant	Roy Zimmerman	1973	H	615	U	OSk/ls
212	4059-7644	R. Schreck	do.	1976	H	600	H	Omh/sh
213	4058-7644	C. Rine	R. R. Hornberger	1958	H	520	W	Omh/sh
214	4059-7634	Milton Hartman	do.	1975	H	875	W	Srl/sls
215	4058-7635	Truman Mitchell	do.	1976	H	740	S	Sb/sh
216	4058-7635	Russell Weaver	do.	1966	H	600	S	Swc/dls
217	4057-7636	Myron Fenstermac	Norman Hagenbuch	1968	H	515	S	Swc/dls
218	4058-7635	Lewis Riley	R. R. Hornberger	1967	H	600	S	Swc/dls
219	4057-7635	Charles Confer	do.	1976	H	585	S	Sto/lsd
220	4058-7634	George Pappas	Wieand 8rothers	1977	H	720	S	Sb/sh
221	4058-7635	W. Raup	Virgil Buck	1978	H	765	S	Sru/sls
222	4058-7636	John Hubicki	R. R. Hornberger	1967	H	680	S	Sru/sls
223	4058-7634	James Blue	---	1966	H	810	S	Smk/sls
224	4057-7635	Kline Albeck	R. R. Hornberger	1967	H	565	S	Swc/dls
225	4058-7637	Glen Hagenbuch	Ronald Randler	1968	H	570	S	Srl/sssh
226	4057-7635	John Krum	do.	1967	H	582	S	Sto/lsd
227	4058-7636	Goven Saienni	R. R. Hornberger	1966	H	680	S	Sru/sls
228	4058-7636	John Hubicki	do.	1968	H	680	S	Sru/sls
229	4059-7638	Pennsylvania Oepartment of Transportation	Kohl 8rothers	1970	H	515	V	Swc/dls
231	4100-7639	George Oietr	---	1968	H	620	W	Oh/sh
232	4059-7638	May's Orive-In	---	1968	H	510	W	Oo/lss
233	4100-7636	Jay Hummer	Wieand Brothers	1974	H	670	S	Dmh/sh
234	4059-7635	John 8urke	---	1975	H	605	S	Omr/sh
235	4059-7637	Larry Mordan	Ronald Randler	1977	H	575	S	Sru/sls
236	4059-7639	Mobil	---	1966	H	580	S	Omh/sh
237	4100-7636	Scott Edmeads	Wieand Brothers	1977	H	555	V	Otr/sssh

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/ pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
70	---	---	---	14	7/80	---	---	---	188	450	Mt-149
135	31	6	---	5	7/80	4	---	---	120	310	150
195	20	6	90;185	25	7/80	---	---	---	---	---	151
506	20	6	89;134;291	60	8/68	3	.03/---	---	---	---	152
125	25	6	25	4	8/80	15	.25/13	2	239	280	153
153	35	6	120	---	---	---	---	---	200	86	154
100	40	6	92;98	---	---	15	---	---	86	250	156
215	20	6	80	11	9/80	1	---	---	52	252	157
---	---	---	---	51	10/80	---	---	---	103	285	158
195	43	6	---	40	4/75	10	---	---	34	90	159
135	21	6	---	---	---	3	---	---	34	77	160
275	20	6	---	---	---	6	---	---	51	180	161
275	20	6	---	---	---	---	---	---	---	---	162
315	20	6	---	95	11/80	3	---	---	---	---	163
105	20	6	92;101	---	---	---	---	---	---	---	164
153	---	---	---	35	11/80	5	.04/---	---	34	132	165
76	16	6	25;73	5	9/67	15	.21/---	---	103	355	166
95	20	6	60;75	30	11/78	15	.23/---	---	---	---	167
140	68	6	90;120	50	7/78	5	.06/---	---	---	---	168
170	19	6	85;160	40	7/78	5	.04/---	---	---	---	169
170	20	6	95;160	45	11/78	12	.10/---	---	---	---	170
170	32	6	90;150	40	9/78	5	.04/---	---	---	---	171
155	31	6	80;110;145	40	11/78	7	.06/---	---	---	---	172
250	31	6	---	18	7/80	25	---	---	---	---	173
285	14	6	50;198	6	4/81	---	.03/3	1	154	550	175
189	---	---	---	17	8/81	---	.07/3	1	103	185	176
---	---	---	---	165	8/81	---	.03/1	.5	68	115	177
175	---	---	---	2	8/81	25	.29/15	2	86	222	178
250	121	6	160;235	73	10/81	6	.10/---	---	103	200	181
170	71	6	60;115;160	30	5/79	6	.04/---	---	---	---	182
200	20	6	95;170	30	5/79	5	.03/---	---	---	---	183
145	20	6	95;140	35	5/79	20	.18/---	---	---	---	184
223	---	---	---	60	11/81	18	.32/9	1	86	230	185
273	---	---	---	39	11/81	5	.04/3	1	51	160	186
200	45	6	100;160	58	11/81	---	.18/7	6	68	160	187
197	60	6	---	68	---	14	---	---	---	---	188
115	61	6	---	---	---	50	---	---	---	---	189
230	40	6	---	25	---	10	---	---	---	---	190
200	---	---	---	20	---	25	---	---	---	---	191
528	28	10	---	68	1/30	---	.15/26	11	---	---	194
75	20	6	---	15	4/74	28	---	---	---	---	202
190	22	6	---	20	9/73	120	---	---	---	---	203
70	36	8	36;50;65	11	1/67	---	3.1/165	8	---	---	204
175	119	7	35;105;165	-3	8/66	---	3.5/55	4	---	---	205
300	98	8	120;180;240	5	5/73	---	.50/70	19	---	---	206
400	60	8	95;160;245; 320;370	20	6/73	---	.14/30	24	---	---	207
394	42	6	215;370	70	10/77	2	---	---	---	---	208
263	41	6	---	---	---	---	---	---	---	---	209
126	20	6	---	8	11/78	---	---	---	---	---	210
110	40	6	---	52	6/78	---	---	---	---	---	211
305	---	---	---	---	---	---	---	---	---	---	212
120	60	6	---	---	---	---	---	---	---	---	213
175	41	6	---	3	10/78	---	---	---	51	98	214
215	20	6	---	---	---	6	---	---	---	---	215
190	---	---	135;185	50	11/66	7	.05/---	---	---	---	216
80	43	6	53;68	28	3/68	6	.19/---	---	---	---	217
95	81	6	85	40	12/67	15	.27/---	---	---	---	218
190	---	---	180	66	10/66	3	.03/---	---	---	---	219
198	20	6	135	30	8/77	5	---	---	---	---	220
200	20	6	120;180	30	7/78	4	.03/---	---	17	280	221
115	51	6	69;96	57	12/67	5	.09/---	---	---	---	222
100	34	6	60;90;98	---	---	6	---	---	---	---	223
216	91	6	150;205	49	6/67	7	.04/---	---	---	---	224
210	20	6	65;205	102	9/81	20	---	---	68	165	225
88	81	6	84	57	8/67	30	---	---	---	---	226
255	46	6	120;150;248	20	10/66	4	.03/---	---	68	145	227
205	---	6	86;175;200	30	2/68	20	.11/---	---	---	---	228
260	190	6	---	16	1/70	---	2.8/34	28	---	---	229
155	22	6	38;81;124;137	10	5/68	10	.07/---	---	---	---	231
175	21	6	114;165	30	6/68	6	.04/---	---	---	---	232
175	21	6	43;80;143;155	41	10/78	6	---	---	---	---	233
155	30	6	---	26	10/78	4	---	---	---	---	234
128	54	6	120	58	11/78	10	.50/---	---	68	148	235
95	21	6	40;89	25	11/66	20	.31/---	---	---	---	236
198	18	6	180	40	5/77	60	---	---	103	220	237

TABLE 23.

Well location		Owner	Driller	Year completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology
Number	Lat-Long							
Mt-238	4059-7639	ARCD	---	1974	H	560	S	Dmh/sh
239	4100-7637	Joseph Kistner	---	1968	H	605	S	Dmh/sh
240	4100-7637	Darwin Oitty	---	1967	H	640	S	Dmh/sh
241	4100-7636	Howard Tanner	---	1967	H	680	H	Omh/sh
242	4059-7638	Stewart Venblehn	---	1967	H	495	W	Sb/sh
243	4100-7637	Mark Roberts	Ronald Randler	1968	H	635	S	Dmh/sh
244	4059-7637	First Baptist Church	---	1977	H	530	S	Swc/dls
245	4058-7637	James Hagenbuch	Ronald Randler	1979	H	595	S	Srl/sls
247	4059-7637	Walter Halterman	do.	1980	H	545	H	Sb/sh
248	4058-7637	Gordon Raup	do.	1981	H	565	W	Srl/sls
249	4058-7638	Wayne Myers	Virgil Buck	1978	H	8D0	S	Srl/sls
25D	4058-7637	George Wagner	Ronald Randler	1978	H	870	H	Srl/sls
251	4058-7641	B. Ludwig	---	1980	H	1,010	H	Srl/sls
252	4108-7643	E. Oonahue	Wieand Brothers	1979	H	---	H	Dtr/sssh
253	4108-7643	G. Leonard	do.	1979	H	---	S	Dtr/sssh
254	4058-7635	J. Stanko	R. R. Hornberger	---	H	750	S	Sru/sls
255	4058-7634	Thomas Forney	Stackhouse	1982	H	1,030	H	Srl/sls
								NORTHUMBERLANO
Nu-157	4056-7637	Fisher Realty	Wieand Brothers	1980	P	595	S	Dmh/sh
158	4056-7637	do.	do.	1980	P	570	W	Dmh/sh
159	4056-7637	Haefner	---	1979	H	605	S	Dmh/sh
160	4056-7637	Larry Bohner	R. R. Hornberger	1967	H	565	S	Dmh/sh
161	4056-7634	Allen Shaffer	do.	1966	H	465	V	Dciv/sssh
162	4056-7635	Wayne Brouse	do.	196D	H	485	V	Dciv/sssh
164	4106-7644	Thelma Strouse	Ronald Randler	1974	H	580	S	Don/lss
165	4106-7644	James Styer	do.	1974	H	560	S	Don/lss
166	4057-7637	William Snyder	R. R. Hornberger	1972	H	525	T	Swc/dls
167	4056-7639	Richard Heller	Ronald Randler	1969	H	475	T	DSk/ls
168	4056-7639	Harold Whitenight	R. R. Hornberger	1967	H	460	T	Dmh/sh
169	4D57-7637	Daniel Fitzgerald	do.	1967	H	470	T	Swc/dls
170	4057-7638	Ralph Shannon	do.	1966	H	530	T	Dmr/sh
171	4057-7638	Fred Reed	do.	1966	C	530	T	Dmr/sh
172	4057-7637	Arthur Fryling	do.	1966	H	500	T	Swc/dls
173	4056-7637	Nevin Beishline	do.	1966	H	610	S	Dmh/sh
174	4057-7637	Stanley Adler	Norman Hagenbuch	1966	H	550	V	Dmh/sh
175	4057-7639	Riverside Church	Virgil Buck	1978	H	495	T	Swc/dls
176	4056-7638	Schmidt	R. R. Hornberger	1970	H	540	S	Dtr/sssh
177	4057-7637	Alex Dshirak	Ronald Randler	1976	H	470	T	Don/lss
178	4057-7637	Raymond Howell	R. R. Hornberger	1967	H	480	T	Do/lss
179	4057-7639	Terry Fry	do.	1977	H	485	T	Swc/dls
180	4056-7637	F. Maresa	---	1976	H	605	S	Dmh/sh
184	4056-7637	Adam Rivito	Wieand Brothers	1977	H	7D5	S	Dtr/sssh
185	4056-7637	Pinebrook Homes	Stackhouse	1981	H	615	S	Dmh/sh
186	4057-7638	Shirley Steffen	R. R. Hornberger	1966	H	470	T	Sb/sh
187	4057-7637	Time Markets	Alvin Swank and Son	1973	H	480	T	DSk/ls
188	4057-7637	David Cooper	---	---	H	48D	T	DSk/ls
189	4057-7637	Fred Geringer	Alvin Swank and Son	1972	H	480	T	Sto/lsd
190	4057-7637	do.	---	---	H	480	T	Qgo/sg
191	4057-7637	S. Wintersteen	---	---	H	465	T	Qgo/sg
193	4055-7646	Beverly Cook	---	1977	H	640	S	Otr/sssh
194	4055-7645	Richard Smith	---	1974	H	560	V	Sto/lsd
195	4055-7645	Steve Klinger	---	1977	H	540	S	Dmh/sh
196	4055-7645	Scott Erdman	---	1977	H	550	S	Dmr/sh
197	4057-7639	D. Barnhart	Ronald Randler	1978	H	470	V	Sb/sh
198	4057-7640	James Thomas	R. R. Hornberger	1977	H	470	V	Swc/dls
199	4056-7640	Charles Brogan	do.	1976	H	470	V	Swc/dls
2D0	4056-7641	William Cole	do.	1975	H	500	S	Sb/sh
251	4157-7638	C. Benjamin	Ronald Randler	1980	H	510	T	Do/lss

(CONTINUED)

Total depth below land surface (feet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gal/min)	Specific capacity [(gal/min)/ft]/pumping rate (gal/min)	Pumping period (hours)	Hard-ness (mg/L)	Specific conduc-tance (µmho/cm at 25°C)	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
131	45	6	---	29	5/74	8	---	---	---	---	Mt-238
74	22	6	40;61	20	5/68	6	.11/---	---	---	---	239
70	34	6	60;68	30	10/67	10	.25/---	---	---	---	240
95	40	6	55;68;85	30	4/67	7	.12/---	---	---	---	241
76	23	6	65	13	7/67	25	.68/---	---	---	---	242
82	20	6	65;70;80	42	7/68	30	3.8/---	---	---	---	243
70	20	6	55;65	10	1/77	20	---	---	---	---	244
261	13	6	100;255	116	9/81	20	.36/---	---	68	160	245
265	16	6	260	59	9/81	3	---	---	171	380	247
137	15	6	130	59	9/81	20	.27/---	---	86	160	248
80	20	6	60;75	20	9/78	8	.13/---	---	86	180	249
191	14	6	185	82	11/78	7	.08/---	---	51	170	250
97	43	6	87	---	---	10	---	---	51	78	251
523	42	6	178	---	---	---	---	---	---	---	252
448	39	6	100	82	6/79	1	---	---	---	---	253
200	105	6	---	---	---	---	---	---	---	---	254
223	40	6	76	46	4/82	6	.05/3	1	86	210	255
COUNTY											
300	42	6	56;91;115;148	26	5/80	20	1.2/18	2	51	100	Nu-157
300	22	6	22;30;88; 108;289	4	7/80	60	.87/60	40	86	181	158
130	---	---	---	56	5/80	---	---	---	---	---	159
95	39	6	45;87;91	44	7/67	8	.16/---	---	---	---	160
80	32	6	60;75	29	6/80	7	.14/---	---	51	190	161
83	---	---	41	25	8/80	35	.53/15	1	51	150	162
80	14	6	75	---	---	---	---	---	---	---	164
74	13	6	70	---	---	---	---	---	---	---	165
175	106	6	---	40	10/72	6	---	---	---	---	166
75	21	6	---	25	2/69	35	1.2/---	---	---	---	167
105	20	6	27;103	25	6/67	40	.50/---	---	---	---	168
150	31	6	140	20	3/67	3	.03/---	---	---	---	169
63	32	6	58	10	9/66	6	.14/---	---	---	---	170
75	38	6	45;61	20	12/66	10	.20/---	---	---	---	171
95	69	6	---	40	9/66	7	.16/---	---	---	---	172
155	31	6	71;109;146	20	11/66	4	.03/---	---	---	---	173
65	27	6	40;55;60	16	11/66	25	.74/---	---	---	---	174
110	87	6	110	---	---	10	---	---	---	---	175
180	60	6	---	17	11/78	---	---	---	---	---	176
61	29	6	55	13	4/76	18	.49/---	---	---	---	177
335	41	6	48;71;104; 203;309	43	7/67	20	.07/---	---	---	---	178
98	92	6	98	53	11/78	40	---	---	---	---	179
125	---	---	---	38	5/80	---	---	---	---	---	180
398	20	6	300	76	12/78	2	---	---	---	---	184
123	---	---	---	38	11/81	12	---	---	51	135	185
70	20	6	50;60	20	7/66	20	.57/---	---	---	---	186
96	83	6	86;95	32	11/81	40	4.2/63	24	188	600	187
80	---	---	69	32	11/81	---	.88/12	2	274	795	188
120	---	---	---	31	11/81	---	.35/7	1	855	2,100	189
47	---	---	---	32	11/81	---	---	---	---	625	190
---	---	---	---	21	12/81	---	---	---	---	---	191
205	60	6	134;175	100	5/77	7	---	---	---	---	193
185	167	6	---	20	6/74	150	---	---	---	---	194
226	42	6	165;195	85	11/77	5	---	---	---	---	195
151	63	6	64;140	2	11/77	8	---	---	---	---	196
137	21	6	130	16	8/78	20	.24/---	---	---	---	197
42	33	6	38	---	---	100	---	---	---	---	198
53	40	6	49	16	1/76	50	---	---	---	---	199
75	57	6	---	20	8/75	10	---	---	---	---	200
90	76	6	70	68	1/80	14	---	---	---	---	251

TABLE 24. RECORD OF SELECTED SPRINGS

Spring location: The number is that assigned to identify the spring. It is prefixed by a two-letter abbreviation of the county. The lat-long is the coordinates, in degrees and minutes, of the southeast corner of a 1-minute quadrangle within which the spring is located.

Use: H, domestic; P, public supply; T, institution.

Topographic setting: S, hillside; T, terrace; W, upland draw.

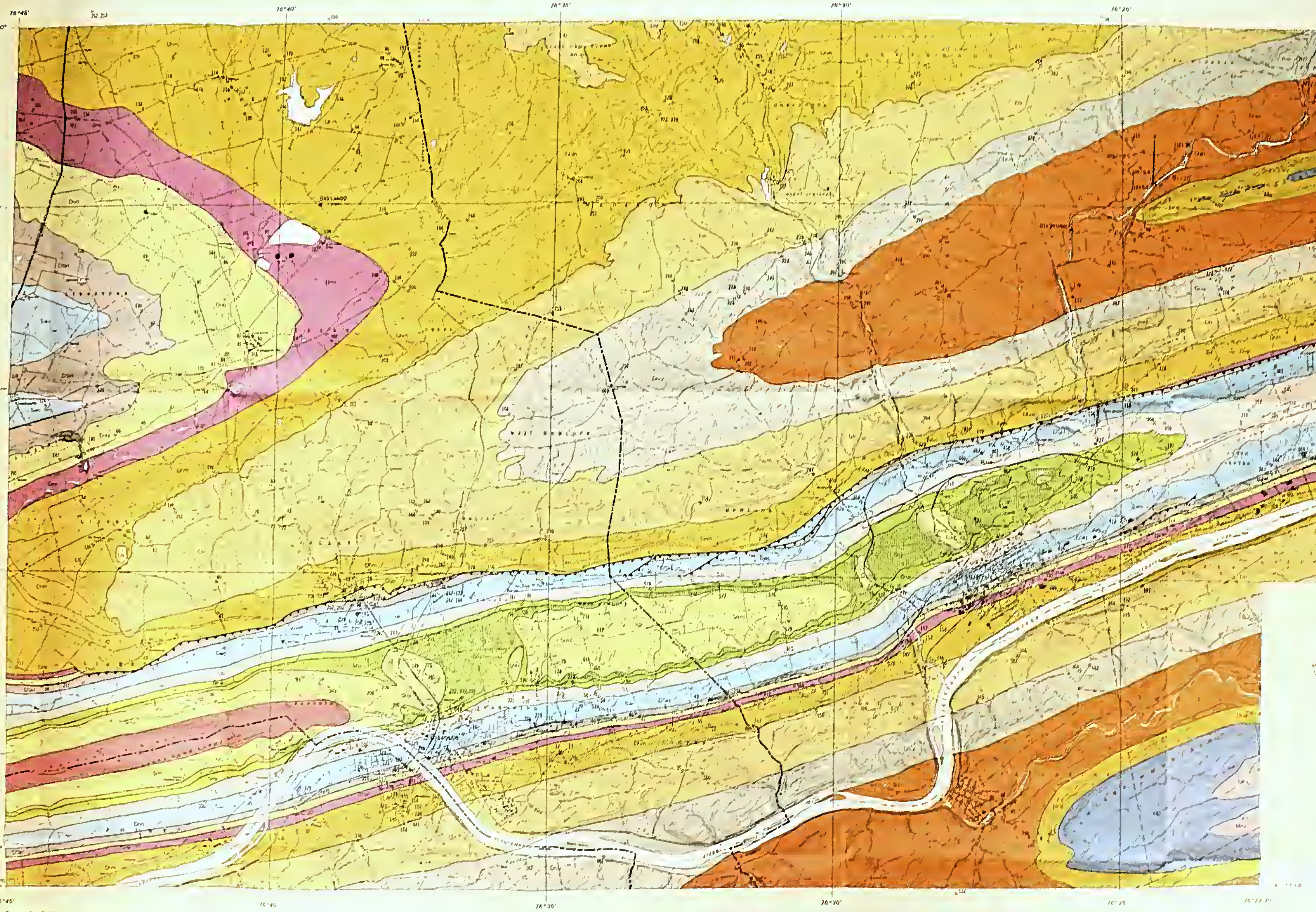
Aquifer: Qgo, glacial outwash; Dcsc, Sherman Creek Member of the Catskill Formation; Smk, Mifflintown and Keefer Formations.

Lithology: sg, sand and gravel; sls, sandstone, limestone, and shale; sssh, sandstone and shale.

Reported discharge: gal/min, gallons per minute.

Spring location		Owner	Name of spring	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/ lithology	Reported discharge (gal/min)
Number	Lat-Long							
Co-Sp-2	4104-7624	Orangeville Water Co.	No. 1	P	670	W	Dcsc/sssh	18
4	4056-7626	Catawissa Water Authority	Upper Hoffman	P	1,280	S	Dcsc/sssh	14
5	4056-7626	do.	Lower Hoffman	P	1,200	S	Dcsc/sssh	14
6	4056-7626	do.	Gensel	P	770	W	Dcsc/sssh	10
9	4101-7622	P. Hartkorn	---	H	490	T	Qgo/sg	2
Mt-Sp-1	4058-7636	Geisinger Medical Center	---	T	540	W	Smk/sls	---

TOPOGRAPHIC AND GEOLOGIC SURVEY
Donald M. Hoskins, *State Geologist*



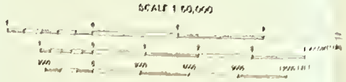
Hydrology by John H. Williams and David A. Eckhardt, 1979-82.

GEOLOGIC MAP OF THE BERWICK-BLOOMSBURG-DANVILLE AREA, EAST-CENTRAL PENNSYLVANIA, SHOWING THE LOCATIONS OF WELLS AND SPRINGS

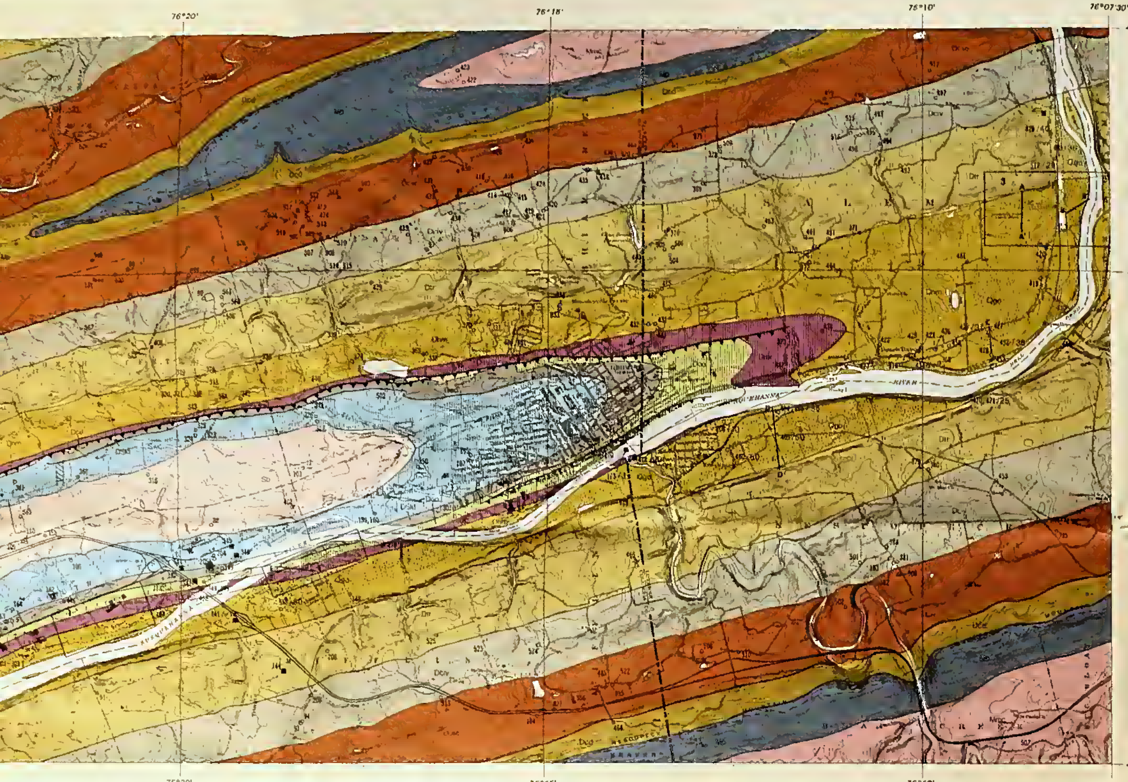
HYDROGEOLOGY
BY
JOHN H. WILLIAMS AND DAVID A. ECKHARDT
1987

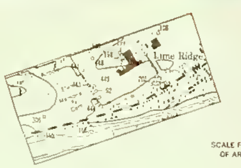
INDEX TO TOPOGRAPHIC MAPPING

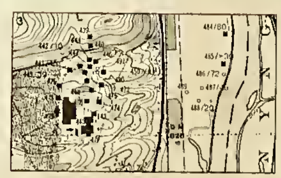
INDEX TO GEOLOGIC MAPPING



LOCATION OF AREA



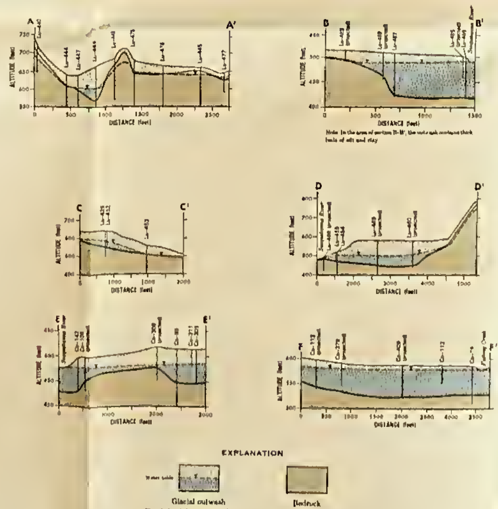




SCALE FOR ENLARGEMENTS
OF AREAS 1, 2, AND 3
1:24,000

0 1/2 1 MILE
0 .5 1 KILOMETER

SECTIONS OF THE GLACIAL-OUTWASH AQUIFER



MEDIAN SPECIFIC CAPACITIES OF BEDROCK WELLS BY LITHOLOGY AND TOPOGRAPHIC SETTING[1]

Geologic units	*Lithology*	Median specific capacity [(gal/min)/ft] *Hilltop*	*Slope*	*Valley*
Harrell, Mahantango, Marcellus, and Bloomsburg Formations	Shale	0.10	0.17	0.31
Catskill and Trimmers Rock Formations	Sandstone and shale	.04	.18	.39
Mifflintown, Keefer, and Rose Hill Formations	Sandstone, limestone, and shale	.04	.10	.95
Onondaga, Old Port, and Wills Creek Formations	Carbonate rock and shale	[2].34	1.8	3.4
Keyser and Tonoloway Formations	Carbonate rock	[2]1.7	[2]4.0	6.0

[1]Taken in part from Table 14
[2]Based on only one pump-tested well.

EXPLANATION

	UNIT	GEOLOGIC DESCRIPTION	WATER-BEARING PROPERTIES	QUALITY OF WATER
QUATERNARY	GLACIAL OUTWASH Qgo	Sand and gravel, containing some clay, silt, cobbles, and boulders.	Median specific capacity of pump-tested wells is 11 (gal/min)/ft. Median estimated well yield is 190 gal/min. About one of every four wells is capable of yielding 410 gal/min or more. Screens and gravel packs are needed for high-yield wells.	Very low to moderate dissolved solids (98 to 291 µmho/cm).[1] Soft (34 to 68 mg/L).[2] Excessive manganese is a common problem. Wells that do not have screens may produce water containing suspended sediment.
MISSISSIPPIAN	MAUCH CHUNK FORMATION Mmc	Interbedded grayish-red shale, siltstone, and sandstone; calcareous in part.	Scant data. Reported yields for two domestic wells (160 and 200 feet deep) are 10 and 20 gal/min.	Data from two wells show very low dissolved solids (20 µmho/cm) and soft water (less than 17 mg/L hardness).
MISSISSIPPIAN	POCONO FORMATION[3] Mp	White to light-gray quartzitic sandstone and conglomerate; some interbeds of dark-gray shale.	No data. Due to upland setting, wells would probably be deep and low yielding.	No data.
DEVONIAN	CATSKILL FORMATION: DUNCANNON MEMBER Dcd	Fining-upward cycles of sandstone, siltstone, and shale; grayish red and greenish gray.	Scant data. Reported yield for an 85-foot-deep domestic well is 30 gal/min.	Data from one well show very low dissolved solids (60 µmho/cm) and soft water (17 mg/L hardness).
DEVONIAN	CATSKILL FORMATION: SHERMAN CREEK MEMBER Dcs	Interbedded grayish-red shale, siltstone, and sandstone.	Median specific capacity of pump-tested wells is 0.29 (gal/min)/ft. Median estimated well yield is 11 gal/min. About one of every four wells is capable of yielding 50 gal/min or more. About one of every four domestic wells requires 60 feet of casing or more because of thick glacial deposits.	Very low to low dissolved solids (65 to 179 µmho/cm). Soft to moderately hard (34 to 68 mg/L).
DEVONIAN	CATSKILL FORMATION: IRISH VALLEY MEMBER Dciv	Interbedded gray, greenish-gray, and grayish-red shale, siltstone, and sandstone.	Specific capacities for two pump-tested wells are 0.34 and 0.53 (gal/min)/ft. Median estimated well yield is 11 gal/min. About three of every four domestic wells are 165 feet deep or less.	Very low to low dissolved solids (82 to 149 µmho/cm). Soft (34 to 51 mg/L).
DEVONIAN	TRIMMERS ROCK FORMATION Dtr	Interbedded gray to dark-gray siltstone and shale; considerable amount of sandstone in the upper part.	Median specific capacity of pump-tested wells is 0.13 (gal/min)/ft. Median estimated well yield is 5 gal/min. About one of every four domestic wells is 275 feet deep or more.	Low dissolved solids (103 to 176 µmho/cm). Soft (34 to 51 mg/L). Hydrogen sulfide is a common problem in water from the lower part of the aquifer.
DEVONIAN	HARRELL AND MAHANTANGO FORMATIONS, UNDIVIDED Dhm	Harrell Formation—Dark-gray shale, interbedded with siltstone in the upper part. Mahantango Formation—Greenish-gray to dark-gray shale, locally calcareous.	Median specific capacity of pump-tested wells is 0.27 (gal/min)/ft. Median estimated well yield is 7 gal/min. About one of every four wells is capable of yielding 22 gal/min or more. About three of every four domestic wells are 175 feet deep or less.	Moderate dissolved solids (219 to 377 µmho/cm). Moderately hard to hard (86 to 154 mg/L). Hydrogen sulfide and excessive iron and manganese are common problems. A 470-foot-deep domestic well, Lu-471, produced saline water (1,600 mg/L chloride).
DEVONIAN	MARCELLUS FORMATION Dm	Dark-gray fissile shale.	Median specific capacity of pump-tested wells is 0.19 (gal/min)/ft. Median estimated well yield is 8 gal/min. About one of every four wells is capable of yielding 23 gal/min or more. About three of every four domestic wells are 123 feet deep or less.	Moderate to high dissolved solids (229 to 452 µmho/cm). Moderately hard to hard (77 to 162 mg/L). Hydrogen sulfide gas and excessive iron and manganese are common problems. A 320-foot-deep domestic well, Co-352, produced saline water (1,300 mg/L chloride).
DEVONIAN	ONONDAGA AND OLD PORT FORMATIONS, UNDIVIDED Doo	Onondaga Formation—Interbedded gray argillaceous limestone and calcareous shale in the upper part; gray to dark-gray noncalcareous to very calcareous shale in the lower part. Old Port Formation—Dark-gray chert, calcareous shale, and limestone; friable sandstone is locally present at the top.	Median specific capacity of pump-tested wells is 3.2 (gal/min)/ft. Median estimated well yield is 91 gal/min. About one of every four wells is capable of yielding 310 gal/min or more. About three of every four domestic wells are 156 feet deep or less. A domestic well that penetrated friable sandstone at depth required 76 feet of casing.	Moderate to very high dissolved solids (207 to 675 µmho/cm). Hard to very hard (162 to 330 mg/L). Hydrogen sulfide gas and excessive iron are common problems.
DEVONIAN / SILURIAN	KEYSER AND TONOLOWAY FORMATIONS, UNDIVIDED DSkt	Keyser Formation—Gray to bluish-gray limestone. Tonoloway Formation—Laminated, gray to dark gray limestone; dolostone in the lower part.	Median specific capacity of pump-tested wells is 4.6 (gal/min)/ft. Median estimated well yield is 180 gal/min. About one of every four wells is capable of yielding 620 gal/min or more. About one of every four domestic wells is more than 210 feet deep and requires 100 or more feet of casing	Moderate to very high dissolved solids (360 to 668 µmho/cm). Hard to very hard (158 to 280 mg/L). Three wells, Co-307, Mt-31, and Nu-189, produced water containing, respectively, 270, 625, and 1,300 mg/L sulfate
SILURIAN	WILLS CREEK FORMATION Swc	Interbedded calcareous shale, argillaceous dolostone and limestone, and calcareous siltstone, gray, yellowish gray, and greenish gray in the upper part; variegated greenish gray, yellowish gray, and grayish red purple in the lower part.	Median specific capacity of pump-tested wells is 3.1 (gal/min)/ft. Median estimated well yield is 99 gal/min. About one of every four wells is capable of yielding 130 gal/min or more. About three of every four domestic wells are 170 feet deep or less.	Moderate to high dissolved solids (238 to 465 µmho/cm). Hard to very hard (136 to 180 mg/L).
SILURIAN	BLOOMSBURG FORMATION Sb	Grayish-red shale containing interbeds of grayish-red siltstone.	Median specific capacity of pump-tested wells is 0.18 (gal/min)/ft. Median estimated well yield is 6 gal/min. About one of every four domestic wells is 211 feet deep or more	Moderate to high dissolved solids (131 to 405 µmho/cm). Soft to moderately hard (51 to 103 mg/L).
SILURIAN	MIFFLINTOWN AND KEEFER FORMATIONS, UNDIVIDED Smk	Mifflintown Formation—Dark-gray calcareous shale and limestone. Keefer Formation—Light-gray quartzitic sandstone and siltstone containing interbeds of greenish-gray shale	Median specific capacity of pump-tested wells is 0.13 (gal/min)/ft for the Mifflintown and Keefer Formations and 0.21 (gal/min)/ft for the Rose Hill Formation. Median estimated well yield is 11 gal/min. About one of every four wells is capable of yielding 56 gal/min or more. About one of every four domestic wells is 223 feet deep or more. Four domestic wells that penetrated old iron ore mines required 70 to 121 feet of casing	Low to moderate dissolved solids (147 to 270 µmho/cm). Soft to moderately hard (51 to 103 mg/L).
SILURIAN	ROSE HILL FORMATION: UPPER MEMBER Srhu	Interbedded shale, limestone, and sandstone; gray to greenish gray.		Low to moderate dissolved solids (145 to 230 µmho/cm). Moderately hard (68 to 86 mg/L).
SILURIAN	ROSE HILL FORMATION: MIDDLE AND LOWER MEMBERS, UNDIVIDED Srhml	Middle member—Reddish-purple sandstone containing interbeds of greenish-gray to reddish purple shale in the upper part. Lower member—Greenish-gray shale containing interbeds of gray calcareous sandstone and reddish-brown hematitic sandstone		Low to moderate dissolved solids (140 to 210 µmho/cm). Moderately hard (69 to 95 mg/L). Excessive iron and manganese are a common problem.
SILURIAN	TUSCARORA FORMATION St	Interbedded light-gray quartzitic sandstone and grayish green shale.	No data. Due to upland setting, wells would probably be deep and low yielding	No data. Probably low dissolved solids and soft water

[1]Range of specific conductance is based on 75 and 25 percent occurrence values from Table 19. The abbreviation "µmho/cm" refers to micromhos per centimeter at 25°C.
[2]Range of hardness is based on 75 and 25 percent occurrence values from Table 19. The abbreviation "mg/L" refers to milligrams per liter as $CaCO_3$.
[3]Includes the Spechty Kopf Formation in the northeastern and south-central parts of the report area.

SYMBOLS

Geologic contact
Includes approximately located and inferred contacts

Thrust fault
Includes approximately located and inferred faults, queried where uncertain. Saw teeth on upper plate

Well and county well number

Test hole and county number

Spring and county spring number

Saturated thickness of glacial outwash, in feet

U.S. Geological Survey stream gaging station and station number

Line of cross section of the glacial outwash aquifer

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